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FUNDAMENTAL READING HABITS: A STUDY OF THEIR DEVELOPMENT

FUNDAMENTAL READING HABITS: A STUDY OF THEIR DEVELOPMENT

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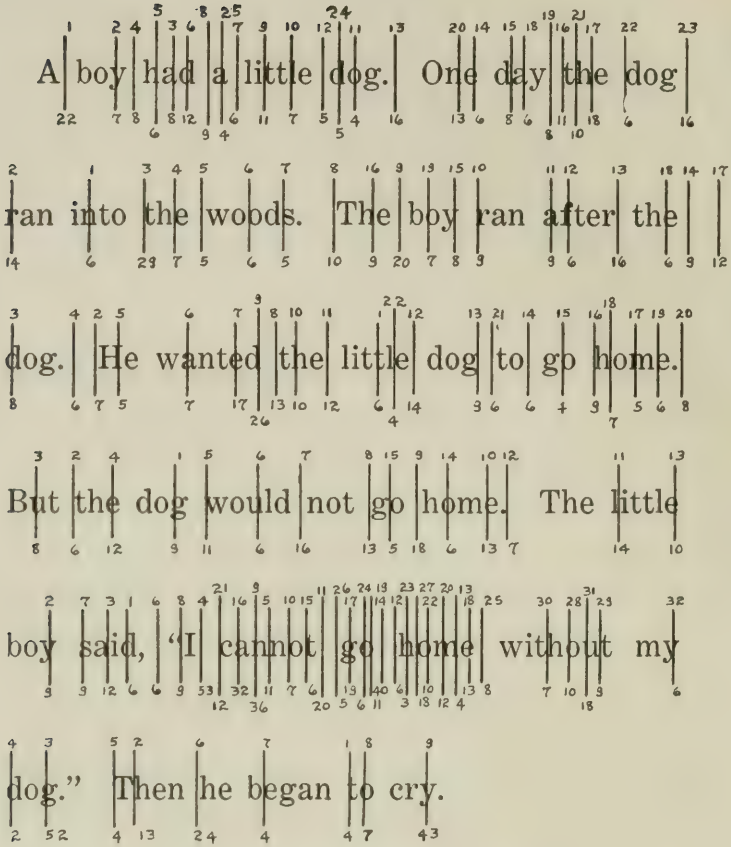
FUNDAMENTALS IN READING

In the silent reading of an easy paragraph, Barbara, a first-grade pupil, read at a rate of 39.6 words per minute, while Miss. W, a college Senior, read at a rate of 369 words per minute. A further analysis of the records of these two readers shows that the first-grade pupil has a very narrow recognition span, making an average of 21.3 fixation pauses per line, while the college student has a very wide span, requiring only 3.6 fixations per line. The first-grade pupil was not sure of her recognition of words even after her eyes had fixated upon them, and consequently found it necessary to make an average of 6.8 backward, or re-fixating, movements per line. The college student, however, did not make a single backward eye-movement in reading the entire paragraph. A further difference between the habits of these two readers can be seen in the duration of their fixations. In spite of the fact that the first-grade pupil had a very narrow recognition span, she required an average of 11.7 twenty-fifths of a second per fixation pause to get a clear perception of this small unit of material; while the college student recognized a much wider unit in an average fixation time of 8 twenty-fifths of a second. The record of the first-grade pupil gave clear evidence of periods of mental confusion, but that of the college student was perfectly regular throughout. The eye-movement records of these two subjects are shown in Plates I and II.

The cases just described illustrate the wide difference between the reading habits of the beginner and the mature reader. The task of the school is to convert the habits of the one into those of the other. While the wide interval between these two extremes is perfectly evident, the detailed steps of growth from the beginning stages to ultimate mature habits are not ordinarily thought of by those who are planning school courses. However, it is with these detailed steps that the teaching process is most concerned. An examination of the records in Plates I and II gives no indication of the nature of the route over which the college student has passed, nor of the manner in which the first-grade pupil may finally reach a similar degree of expertness in reading. What the records do show is the meaning of immaturity and of maturity. When the ultimate goal of reading instruction is known, the teacher is at liberty

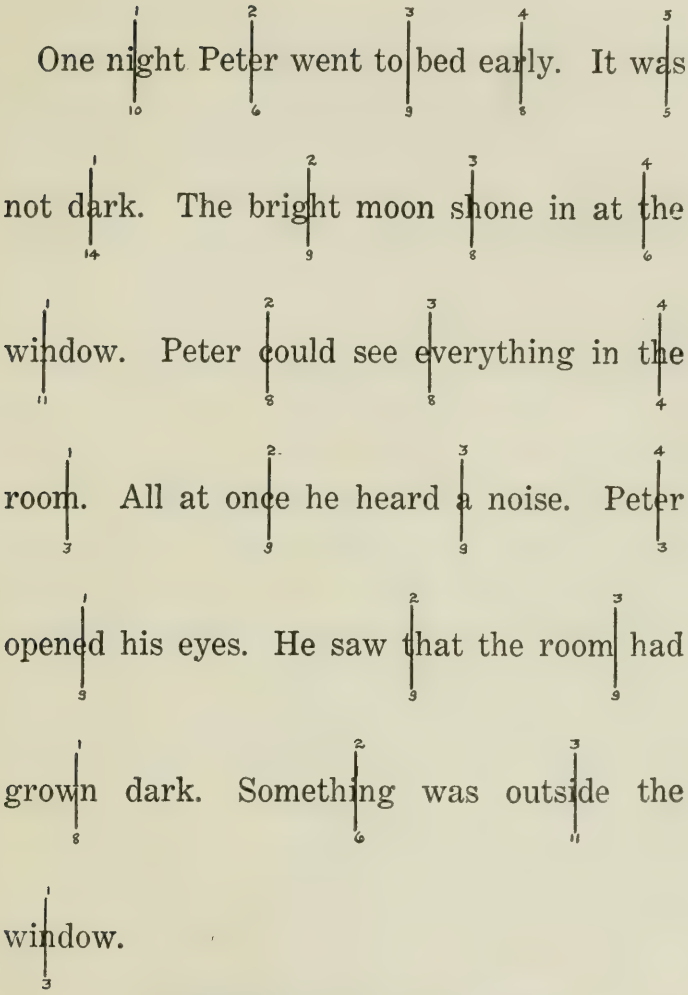
PLATE I*



Silent reading by Subject 17, Grade IA

*In all plates showing records of eye-movements the positions of the eye-fixations are indicated by the short vertical lines drawn across the lines of print. The serial numbers above the verticals indicate the order of the pauses; the number at the lower end of each vertical indicates, in twenty-fifths of a second, the duration of the fixation. A cross appearing instead of a number at the lower end of a vertical indicates that the duration of the fixation could not be determined with precision. An oblique line indicates a pronounced head-movement, the exact location of the fixation being at some point between the ends of the oblique.

PLATE II



Silent reading by Subject 174, college Senior

to use whatever methods may be considered best, provided always that the final outcome is in accord with the known characteristics of maturity.

The reading process is a complex made up of many elements. Although the mature reader has attained a high degree of mastery of all of these, he frequently does not progress uniformly in the various elements. The rate and order of development of the different reading habits depend largely upon the methods by which the subject is taught. The use of different methods simply means that pupils are being led over different routes in their journey toward maturity. In all probability these various routes are not equally economical, but they must be judged not by an observation of any particular point along the way, but rather by the manner in which they finally issue in attainment of the desired goal of maturity. The conviction that the various routes are not all equally economical leads one to ask what methods of education will ultimately be most desirable, that is, what methods carry the pupil from start to finish by the most advantageous route. The psychologist, however, is not concerned merely with the questions of advantage or disadvantage. He is concerned as a scientist with all the possible routes which are actually followed. His problem is broader than that of the practical teacher who is seeking economy. He is compelled therefore to study all varieties of reading. Regardless of which elements of reading are, in a particular case, developed first, he will take note of the common elements and will thus contribute to practical procedure because many methods of teaching without doubt develop ultimately all the elements which are fundamental to the process.

Certain characteristics of the period of transition from immaturity to maturity may be described without the assistance of elaborate experimental investigation. One of the most conspicuous elements in the growth of reading habits is the ability to pronounce words. The beginner finds this a very difficult process. His method of attacking an unknown word depends upon the manner in which he has been taught, but whether he recognizes the word by general inspection or by phonic analysis, a considerable amount of mental effort is involved. As the child advances through the grades pronunciation becomes progressively easier, requiring, for the mature reader, only a minimum of consciousness. The teacher can determine progress in this element by a simple pronunciation test and can easily chart the normal growth curve for a class.

Another element of reading consists in the ability to recognize the meaning of words. This is a more difficult process than simple pronunciation since it involves not only a recognition of the word but

also an extension of experience sufficient to provide a meaningful content with which the word may be associated. The word "radio" is not difficult to pronounce, but until the present year few elementary children were familiar with its meaning because it was not a part of their experience. Since a recognition of the meaning of words demands a breadth of experience which includes the word, it is clear that ultimate maturity in this element will be a difficult point to reach. However, the extension of the pupil's vocabulary to provide for the recognition of common words is one of the fundamental requirements of the course in reading.

A third element, and one which involves still further difficulties, is the ability to interpret sentences or paragraphs. In this respect the difference between the immature and the mature reader is very great. The tendency of some beginners is to conceive of reading as the consecutive pronunciation of words. In so doing their consciousness is almost entirely focused upon the separate words rather than upon the thought of the sentence or paragraph. The mature reader, on the other hand, devotes practically his entire consciousness to the process of thought interpretation. Maturity in interpreting words in their relations involves the ability to fuse a number of words, in the particular order in which they occur, into a single thought whole. The demand is chiefly upon the higher mental processes rather than upon the eye, although until the eye has so mastered the perception of words that attention can be withdrawn from the act of fixation, it will be impossible to give maximum attention to the process of interpretation. Growth in this element is, as would be expected, a process which extends throughout the entire school period. It is complicated by the continuous presentation of increasingly difficult materials in the upper grades. Growth in ability to interpret the meaning of a passage has generally been regarded as the most vital element in reading. All teachers of reading have at least a general concept of the growth stages in this process; while some, by the careful use of tests of comprehension, have a very definite notion of the successive stages of progress. The recent emphasis on the teaching of silent reading is one indication of the recognition of the need of growth in interpretation.

The nature of the transition from immaturity to maturity has been described for three elements of the reading process, namely, ability to pronounce words, ability to recognize the meaning of words, and ability to interpret the meaning of sentences and paragraphs. More detailed analyses of these and other elements need to be made. A number of methods are available.

One useful means of determining the stage of transition from immaturity to maturity is the measurement of the rate of reading. Rate has been widely studied, and the general norms of progress for each grade are well known. While individual variations are found, the fact remains that in general the mature reader is the rapid reader, showing the most striking contrast, in this respect, with the beginner. For the two cases described at the opening of this chapter, the rate of the college student was nearly ten times as great as that of the first-grade pupil. The measurement of rate is one of the simplest means of determining the maturity of the reading process.

Another method of analysis consists in measuring results by means of standardized educational tests. By this means reading has been studied in respect to such characteristics as rate, comprehension, ability to follow printed directions, etc. This method has proceeded by formulating various types of tests from which mass data have been obtained. From these mass data grade norms are determined, in comparison with which individual cases may be studied. As instruments of analysis, standardized tests possess certain merits as well as certain marked limitations. Their most pronounced limitation is that they deal with results rather than with the processes back of the results; with complexes rather than elements. The tests give a comprehension score, but do not analyze the components of the mental processes involved. They measure rate of reading, but do not tell whether the rate is a product of a narrow recognition-span and a short average fixation time, or of a wide recognition-span and a long average fixation time, or of an average development of each. An adequate analysis must go back of a raw statement of rate to a measure of component elements of the reading process.

Still another method of analyzing the steps of transition to maturity in reading is by careful teaching. There is no doubt that the superior teacher can note with more or less precision the change from stage to stage in the progress of the pupils. Teachers who construct a definite scheme of methods for the express purpose of developing certain elements in a certain order are able to ascertain with a fair degree of accuracy when particular stages are reached. It would not be safe to assume, however, that what can be done by a superior teacher with a considerable fund of experience can be done by the average teacher of reading. From all observation, it is only the superior teacher who analyzes the progress of her pupils.

While some analysis of growth stages in reading can be made through the use of standardized tests and through the processes of superior teaching, it is clear that a detailed analysis of the reading process itself is beyond the reach of both. A satisfactory method of studying the

growth of reading habits must rest upon the measurement, either directly or indirectly, of some aspect of the actual process of reading. Furthermore, this method must be objective in character, rather than dependent upon the subjective judgment of even a superior teacher. The method which most fully meets these requirements is that of photographing the eye-movements of a pupil during the process of reading. Eye-movements are by no means the whole of the reader's activity when looking at the printed page but they are parts of his nervous and muscular effort in reading. Furthermore, they furnish the most objective symptoms available of the mental processes of the reader.

The study of the reading process through the medium of photographic records of eye-movements is not a new method. However, since a summary statement of the meaning and significance of the data thus obtained has not appeared in the previous literature of reading, a somewhat detailed discussion here may be of value in interpreting the material presented in the following chapters.

Eye-movements as such are purely mechanical processes, being, at least superficially, the result of the contractions of the external muscles of the eye rather than of any central thought processes of the mind. And yet, just as hand-movements are necessary to writing, so also the processes of reading cannot be carried on without eye-movements; and just as good writing demands a careful control of hand-movements, so also mature reading demands a delicately co-ordinated type of eye-movements. Handwriting requires a fine control of finger, hand, and arm muscles which is unlike any co-ordination which the child learns in his ordinary activities. Therefore, the school attempts to teach him to meet the artificial demands of the handwriting process by a long series of formal drill exercises. Reading requires a delicate and continuous control of small eye-movements which is entirely different in character from any natural demands which the pre-school experience of the child has presented, but the school treats this matter in a very different manner from the similar situation in handwriting. There are at least two reasons for this difference in treatment. The first is the fact that writing seems to be the immediate result of hand-movements, while reading, as a process of recognition and interpretation, goes very much beyond the movements of the eyes. A second reason is the fact that eye-movements are not so easily subject to direct, conscious control as are hand-movements, it being necessary to develop the former in an indirect manner. Ordinarily teachers as well as pupils do not think at all about eye-movements. The adjustments involved are accomplished through ordinary reading processes.

However, the significance of eye-movements goes far beyond the mechanics of reading. The use of eye-movment records in the analysis of reading rests primarily upon the fact that they furnish an objective symptom of the character of the reading process. Unless the attention of the reader is specifically directed to them he is entirely unconscious of their nature. Consequently, a photographic record of eye-movements is based upon a reaction which cannot be consciously modified to suit the occasion of a test. It is as difficult to modify directly one's eye-movements while reading as it is to modify purposely the character of one's habitual gait in walking. A person walks in one manner when hurrying to catch a train, in another when strolling through the park, and perhaps in a still different manner when stepping to the speaker's desk upon a platform when a thousand eyes are focused upon him. His manner of walking is the unconscious expression of his whole nervous condition under such circumstances, a symptom of the purpose dominating his action. When we see a man rushing down the street we do not infer that he is taking a stroll. Furthermore, we do not confuse the toddle of the infant with the vigorous stride of the adolescent or the more dignified step of maturity. A person's walking furnishes a symptom of his stage of maturity. In a similar fashion a person's eye-movements furnish an index of the general nature of his reading process, a symptom of the stage of maturity of his reading habits. When we see a person making an average of 20 fixations per line in reading we know that he is not grasping the meaning easily or rapidly. In like manner, when we observe a person making an average of 4 fixations per line we know that he is either reading superficially or has reached a mature stage of reading. The making of only 4 eye-fixations does not cause maturity of reading; maturity causes the making of only 4 fixations per line. Eye-movements are effects, symptoms; but they are symptoms because they are themselves necessary phases of the process and hence very fundamental elements of reading. The fact that they are not subject to direct conscious control makes them reliable as a measure of reading ability. The further fact that they are entirely objective in character, capable of yielding an accurate photographic record, makes the use of eye-movements one of the most significant methods for the analysis of growth in reading. It is this method of analysis which has been employed in securing the greater part of the data for this investigation.

A careful survey of the previous monographs dealing with eye-movements, as well as the data of the present study, will show the manner in which the eye-movements of a reader furnish a symptom of

the character of his thought processes. One of the first indications of such a relationship appeared in a study of the effect of size of type upon the habits of eye-fixation. If eye-movements were purely sensory accommodations one would expect to find their number increased by an increase in size of type. However, change in the type produced only a slight difference in the character of the eye-movements. The conclusion drawn was that the sensory conditions of reading were not of as great importance as the individual's habits of reading, and that the amount the reader recognizes depends upon his training. The unit of recognition is not determined by so many millimeters of space, but by certain meaningful units which remain fairly constant, even though the print may be enlarged in size.

Another indication of the close relationship between eye-movements and thought processes is furnished by the fact that a period of confusion in the recognition of meaning is accompanied by a corresponding confusion of eye-movements. A close checking of eye-movements with a dictaphone record of oral reading brings out this relationship very clearly. The same fact can be shown through introspective accounts of difficulties in silent reading, or through the introduction of words having a dual pronunciation and a dual meaning. An analysis of the eye-movement record gives a clear indication of where the reader experienced confusion in getting the meaning.

The introduction of strange or difficult words produces a marked effect upon the character of the eye-movements; and conversely, when these characteristic forms of eye-behavior are observed in a record, one feels justified in assuming that some difficulty in word-recognition has occurred. It is further found that increasing the difficulty of a selection tends to increase the number and duration of eye-fixations.

The character of the eye-habits is radically affected by reading varied types of material, the eye behaving differently when the material read is simple fiction than it does when the material is taken from an algebra or a rhetoric textbook. When the characteristic eye-movements are known, therefore, one may gain some idea of the relative difficulty of different kinds of material for a given individual. Likewise, a change in the purpose of reading is reflected by the eye-movements. During serious, careful reading such as occurs in the study process the number and duration of the fixations are increased.

An investigation of the eye-voice span in oral reading has shown a definite tendency of the eye to modify its behavior according to sentence units. A disregard of sentence units by an immature reader can be noted from the character of the eye-voice relationship.

Using eye-movement symptoms as the basis of investigation, it is the purpose of this monograph to study the development of certain fundamental reading habits. Defining reading as the process of getting meaning from printed material, the first fundamental is the development, on the part of the child, of a correct attitude toward reading-matter. Although this attitude may be too complex to class as an "element," its requirements are that the child recognize that the groups of words, in the order in which they are printed, represent certain ideas, and that to get these ideas, the words must be read in the order in which they appear. Sooner or later the pupil takes the attitude that reading consists of gaining ideas from groups of words, rather than that it is an arithmetical process of adding word to word.

When this attitude has been adopted by the child, the process of growth toward maturity has been started. By way of general indication of the kind of changes which are discoverable through a study of eye-movements the following list of aspects or elements of the reading process and its development may be enumerated.

1. The development of a broad recognition unit, as measured by the average scope of eye-fixations.

2. The development of habits of quick recognition, regardless of the size of the unit, as measured by the duration of fixation pauses.

3. The development of precision of recognition and regularity of progress across printed lines, as measured inversely by regressive, or backward, eye-movements.

4. The development of habits of expression or recognition in terms of thought units, as measured, for the oral process, by timing the rhythm of pronunciation.

5. The development of independence in word-recognition.

An analysis of the steps of growth in these several elements makes possible a better understanding of the nature of the transition from immaturity to maturity in reading. The method of investigation consists of the taking of a cross-section view of the stages of development of a large number of subjects, selected from all of the grades of the schools Since ultimately all of the subjects will approximate the stage of maturity, an examination of the successive cross-sections will show not only the general trend of development in the different elements for the majority of the subjects, but also the variations of certain subjects from the general norms of growth. It is the purpose of this monograph to provide an analysis of these fundamental elements which will make possible a description of the normal growth curves and an explanation of the situations in which pronounced variations from the norms are apparent.

CHAPTER II

GROWTH STAGES OF CERTAIN ELEMENTS OF READING

Problem.—The first problem with which the present investigation is concerned is the determination of the stages of growth for three fundamental elements of reading. These elements are, first, the span of recognition for printed material; second, the rate of recognition regardless of the size of the recognition unit; and third, the regularity or rhythmic progress of the perceptions along the printed lines. The basic data utilized in determining the growth curves were secured from the measurement of the three primary characteristics of eye-movements, which are symptoms, respectively, of the fundamental elements just mentioned. These characteristics are, first, the average number of fixations per line; second, the average duration of fixations; and third, the average number of regressive movements per line.

Growth in these elements of reading will be measured, first, by noting the improvement in each element in the successive school grades, and, second, by noting the improvement in each element which accompanies successive degrees of maturity in reading as measured by a standardized test of comprehension in silent reading and a standardized test of general achievement in oral reading.

The method of securing and plotting the photographic records has been described rather fully in a previous monograph of this series[1] and need not be repeated in full here. A brief summary of the method may, however, be of some service. It consists of photographing a beam of light, generated by a high-power nitrogen bulb, reflected first to the cornea of the eye from silvered glass mirrors, and then from the cornea through a camera lens to the moving kinetoscope film. The direction of the pencil of light is changed with each movement of the eye. While the subject reads a photograph is made which records the horizontal movements of the eye as a sharply focused line upon the film. An electrically driven tuning-fork, with a vibration rate of twenty-five per second, is mounted in the path of the beam of light in such a manner that the pencil of light is intercepted at each vibration. These vibra-

[1] G. T. Buswell, *An Experimental Study of the Eye-Voice Span in Reading*, Supplementary Educational Monographs, No. 17, pp. 3–7. Chicago: Department of Education, University of Chicago, 1920.

tions produce on the film a line of dots rather than a solid line, each dot representing exactly one twenty-fifth of a second. Since the film moves continuously in a vertical plane, the record shows a vertical line of dots while the eye is fixated in a single position, and a short horizontal line when the eye is in motion in a horizontal or oblique direction. Vertical movements of the eyes are lost. A bright nickel-plated bead fastened to a pair of spectacle rims worn by the reader makes a second line upon the film, which furnishes an index of head movement and gives a constant point of reference for plotting the film. The method makes possible an accurate record showing the position and duration of each fixation of the eye while the subject reads.

The apparatus used in this part of the investigation is the same as that used by other investigators in the Chicago laboratory, with the exception of four rather important modifications. A complete description of the apparatus prior to these modifications may be found in a monograph by C. T. Gray.[1]

The first change in the apparatus consisted in substituting for the arc-lamp a 400-watt nitrogen bulb containing a series of six parallel filament coils. This bulb gave an intensity of light which was entirely satisfactory, and it possessed the added advantage of being absolutely constant in position and quality of light, since it required no continuous readjustments as are necessary with the carbons of an arc-lamp.

A second modification was the substitution of a tuning-fork time marker with a vibration rate of 25 per second in place of the previously used fork with a rate of 50 vibrations. This modification was made for the purpose of reducing the labor of counting the time dots on the films. Since the shortest fixations are considerably longer than one twenty-fifth of a second, the validity of the record is in no way impaired. The point should be carefully noted, however, that the duration of fixations in all data in the present monograph is given in terms of twenty-fifths of a second, while in the previous studies from the Chicago laboratory the time unit was one fiftieth of a second.

A third change in the apparatus was made in the film carriage. Previous to the present study the apparatus was limited to the use of a 48-inch film. At the rate of movement across the path of light, a film of this length allowed approximately one minute of reading time. The use of such a short film, therefore, seriously limited the amount of

[1] C. T. Gray, *Types of Reading Ability as Exhibited through Tests and Laboratory Experiments*, Supplementary Educational Monographs, Vol. I, No. 5, pp. 83–90. Chicago: Department of Education, University of Chicago, 1917.

material which could be read at a single sitting. It is desirable that a much longer sample of reading be secured. To make this possible, a new mechanism was installed by means of which kinetoscope film can be used. As the apparatus stands at present a two-hundred-foot spool of film can be inserted in one of the film boxes, which makes possible a continuous picture for any duration of time up to forty minutes. The practical uses of the apparatus are greatly increased by this modification.

The fourth change consisted in the construction of a special tachistoscopic device for holding the material to be read. It allows three selections of material to be presented to the reader by the simple pulling of a lever, which causes the reader about the same amount of disturbance as turning the pages of a book. It makes possible the use of longer selections with no interruption of the reader.

Subjects.—In gathering data on this problem, photographic records were taken of the eye-movements of 186 different subjects selected from all grades of the elementary school and high school, and from an adult college group. With the exception of ten first-grade children and fifteen high-school students all were selected from the University of Chicago laboratory schools. The exceptions noted were drawn from public schools near the University. In selecting subjects below the high-school level for this part of the investigation exceptionally good and poor readers were eliminated, since the purpose was to find the normal growth curves. In Grades II to VI this elimination was based upon scores in standardized reading tests. In the first grade the teacher excluded the most mature and immature readers on the basis of their class work. The high-school and college group were not selected on the basis of reading ability since no reading scores were available. For the most part they were students of average scholarship, although in the high-school junior class some students were included who ranked as superior. The number of subjects from each grade and their individual eye-movement data are shown in Tables I and II.

Selections read.—With the exception of the first-grade pupils all subjects read the same selection. The purpose of using the same paragraphs throughout was to keep this element constant in order that the growth curves would not be affected by varying degrees of difficulty in the material. With a constant selection to be read, the degree of difficulty will vary according to the maturity of the subject's reading habits. The first paragraphs used were easy enough to be read by pupils from the second grade up, but first-grade children found them too diffi-

TABLE I

GENERAL DATA FOR SILENT READING—ALL SUBJECTS*

Subject	School Grade	Average Number Fixations per Line	Average Duration of Fixations	Average Number Regressive Movements per Line	Monroe Comprehension Score
1	I B	17.8	10.7	3.8	.....
2	I B	18.0	17.0	5.2	.....
3	I B	18.0	13.2	5.8	.....
4	I B	18.8	17.3	4.5	.....
5	I B	14.5	14.4	3.5	.....
6	I B	18.0	16.4	5.3	.....
7	I B	21.3	23.5	6.5	.....
8	I B	19.0	13.0	4.3	.....
9	I B	27.5	19.3	7.0	.....
10	I A	14.0	9.0	3.0	.....
11	I A	16.5	10.8	4.0	.....
12	I A	21.5	10.9	6.8	.....
13	I A	13.5	11.5	4.0	.....
14	I A	15.0	10.2	3.0	.....
15	I A	7.0	6.8	0.8	.....
16	I A	15.3	9.8	3.3	.....
17	I A	21.3	11.7	6.8	.....
18	I A	16.8	18.0	4.0	.....
19	I A	20.8	10.3	6.0	.....
20	I A	14.8	11.3	3.5	.....
21	I A	11.0	15.4	2.5	.....
22	II A	12.3	10.0	3.3	.....
23	II A	9.5	7.9	1.6	.....
24	II A	10.6	6.9	2.9	.....
25	II A	10.1	12.2	2.3	.....
26	II A	10.4	7.0	2.1	.....
27	II A	10.2	9.2	2.0	.....
28	II A	11.1	9.8	2.1	.....
29	II A	10.6	8.3	2.1	.....
30	II A	9.5	7.7	1.5	.....
31	II A	9.6	8.5	1.3	.....
32	II A	11.4	9.3	2.3	.....
33	II A	10.6	9.4	2.9	.....
34	II A	6.9	7.3	1.4	.....
35	II A	13.8	9.4	3.8	.....
36	II A	13.2	11.5	3.2	.....
37	II A	6.1	9.3	0.6	.....
38	II A	20.5	9.5	8.5	.....
39	II A	11.4	8.5	3.6	.....
40	III A	7.2	6.3	1.2	21
41	III A	7.3	7.5	0.3	20
42	III A	8.4	8.5	1.7	13
43	III A	8.6	7.0	1.4	20
44	III A	8.6	7.7	1.3	13
45	III A	9.5	8.0	1.4	11
46	III A	9.2	7.9	1.8	7

* In computing all averages, data for the first and last lines were omitted.

TABLE I—*Continued*

Subject	School Grade	Average Number Fixations per Line	Average Duration of Fixations	Average Number Regressive Movements per Line	Monroe Comprehension Score
47	III A	6.1	6.9	0.9	17
48	III A	10.6	9.3	1.9	14
49	III A	7.5	9.5	2.2	11
50	III A	9.2	9.8	2.8	11
51	III A	9.6	7.8	3.5	13
52	III A	11.6	8.8	3.0	10
53	III A	8.6	6.3	2.0	17
54	III A	10.6	8.4	2.1	15
55	IV A	6.0	7.7	0.5	26
56	IV A	8.5	5.7	2.3	30
57	IV A	8.7	7.8	1.3	26
58	IV A	6.9	7.2	1.2	34
59	IV A	10.8	8.4	2.5	18
60	IV A	12.5	6.0	3.3	15
61	IV A	6.5	6.0	0.8	29
62	IV A	7.4	9.3	1.0	15
63	IV A	9.4	6.3	2.3	30
64	IV A	6.5	6.0	1.8	30
65	IV A	7.3	6.6	2.0	24
66	IV A	8.2	6.0	1.5	21
67	IV A	6.4	5.6	1.0	.....
68	IV A	6.5	6.8	0.7	30
69	IV A	6.8	6.7	0.8	21
70	V	9.6	5.4	2.5	21
71	V	6.9	5.5	1.3	27
72	V	8.2	6.3	1.3	30
73	V	6.0	5.8	1.2	30
74	V	6.9	7.0	1.8	30
75	V	8.0	6.1	2.0	34
76	V	5.3	5.6	0.4	34
77	V	6.2	6.6	1.2	27
78	V	11.7	6.4	3.2	27
79	V	6.3	7.3	1.4	30
80	V	6.1	6.2	0.2	30
81	V	6.2	6.0	0.7	30
82	V	7.5	5.6	0.5	30
83	V	7.0	5.7	0.4	27
84	V	5.2	6.2	1.1	31
85	V	8.4	6.5	3.4	24
86	VI A	6.9	5.8	0.5	42
87	VI A	7.9	5.9	1.5	35
88	VI A	6.8	5.0	1.8	29
89	VI A	6.5	6.3	1.7	40
90	VI A	5.9	6.2	1.2	42
91	VI A	7.1	6.0	0.5	42
92	VI A	8.3	5.3	2.0	24
93	VI A	5.7	7.1	0.7	42
94	VI A	8.3	5.9	2.0	35

TABLE I—*Continued*

Subject	School Grade	Average Number Fixations per Line	Average Duration of Fixations	Average Number Regressive Movements per Line	Monroe Comprehension Score
95	VI A	7.1	5.1	1.3	45
96	VI A	6.2	5.9	1.7	42
97	VI A	7.8	6.3	0.7	33
98	VI A	7.5	5.5	0.8	39
99	VI A	7.7	6.2	2.3	29
100	VI A	7.8	5.7	1.6	40
101	VI A	6.3	5.4	1.3	33
102	VI A	7.3	6.2	1.5	38
103	VI A	10.1	6.1	3.1	18
104	VI A	8.8	5.4	1.9	32
105	VII	5.4	7.3	1.0	.....
106	VII	6.2	6.3	1.6	.....
107	VII	6.4	5.9	1.0	.....
108	VII	6.4	6.9	0.2	.....
109	VII	8.5	5.9	1.0	.....
110	VII	8.8	5.3	2.0	.....
111	VII	6.8	6.4	1.6	.....
112	VII	8.6	5.9	2.2	.....
113	F	7.2	6.6	1.6	.....
114	F	6.4	5.0	0.2	.....
115	F	6.2	6.5	0.6	.....
116	F	7.2	7.4	0.8	.....
117	F	8.8	5.3	2.2	.....
118	F	4.6	6.0	0.6	.....
119	F	9.0	5.6	1.4	.....
120	F	8.6	9.9	2.6	.....
121	F	6.8	5.3	0.8	.....
122	F	5.6	5.8	0.6	.....
123	F	7.0	6.2	1.0	.....
124	So	4.0	6.9	0.2	.....
125	So	5.6	6.0	0.4	.....
126	So	5.4	6.8	0.8	.....
127	So	7.4	9.9	0.8	.....
128	So	7.2	5.3	1.0	.....
129	So	4.5	5.6	1.0	.....
130	So	7.2	6.6	0.4	.....
131	So	9.4	6.4	2.4	.....
132	So	5.0	6.6	0.2	.....
133	So	7.4	5.5	0.6	.....
134	So	5.8	5.7	0.8	.....
135	So	5.3	4.5	0.8	.....
136	J	5.8	5.2	0.8	.....
137	J	6.6	6.8	0.4	.....
138	J	5.6	6.2	0.0	.....
139	J	4.6	5.4	0.8	.....
140	J	5.0	4.8	0.2	.....
141	J	7.6	5.4	0.8	.....
142	J	4.6	5.3	0.2	.....

TABLE I—*Continued*

Subject	School Grade	Average Number Fixations per Line	Average Duration of Fixations	Average Number Regressive Movements per Line	Monroe Comprehension Score
143	J	7.6	6.0	1.2	
144	J	6.0	5.7	0.0	
145	J	4.6	6.3	0.4	
146	J	5.8	5.4	0.5	
147	J	7.0	4.1	1.0	
148	J	6.0	5.9	1.6	
149	J	5.0	6.5	0.8	
150	J	4.6	5.8	0.6	
151	J	4.4	5.9	0.0	
152	J	4.2	5.7	0.8	
153	J	5.6	5.8	0.8	
154	J	5.8	5.9	1.4	
155	Se	7.6	6.4	1.4	
156	Se	5.0	6.0	0.0	
157	Se	5.0	5.2	0.3	
158	Se	6.6	5.4	0.4	
159	Se	6.2	6.3	0.6	
160	Se	6.8	5.7	1.6	
161	Se	4.6	6.7	0.6	
162	Se	5.7	8.3	0.0	
163	Se	7.4	5.5	0.0	
164	Se	7.2	6.0	1.6	
165	Se	6.8	6.6	0.8	
166	Se	6.8	5.4	1.2	
167	Col	5.6	6.3	0.2	
168	Col	4.4	5.4	0.2	
169	Col	6.4	6.2	0.6	
170	Col	6.0	6.6	0.4	
171	Col	6.8	6.2	0.8	
172	Col	6.6	6.0	1.6	
173	Col	6.0	6.3	0.6	
174	Col	3.6	8.0	0.0	
175	Col	4.2	6.5	0.2	
176	Col	5.6	5.7	0.7	
177	Col	6.2	5.9	0.8	
178	Col	5.8	4.8	0.0	
179	Col	5.0	6.2	0.0	

TABLE II

General Data for Oral Reading—All Subjects*

Subject	School Grade	Average Number Fixations per Line	Average Duration of Fixations	Average Number Regressive Movements per Line	Modified Gray Score
1	I B	22.0	12.3	5.2	.....
2	I B	18.0	13.3	5.0	.....
3	I B	14.4	12.0	4.0	.....
4	I B	18.6	20.1	6.4	.....
5	I B	10.3	12.6	1.3	.....
180	I B	16.3	19.3	4.8	.....
181	I B	11.7	13.6	3.0	.....
6	I B	13.0	27.4	3.0	.....
7	I B	18.2	31.2	4.4	.....
8	I B	13.2	19.9	2.0	.....
9	I B	25.4	19.9	8.8	.....
10	I A	15.8	16.4	5.0	.....
11	I A	12.8	11.9	2.2	.....
12	I A	15.4	12.6	3.6	.....
13	I A	11.0	13.3	2.4	.....
14	I A	11.6	8.9	2.2	.....
182	I A	15.4	22.7	3.4	.....
15	I A	10.0	8.2	1.2	.....
16	I A	14.6	12.4	3.8	.....
17	I A	14.6	10.6	4.2	.....
18	I A	16.2	14.3	3.6	.....
19	I A	16.8	10.9	3.0	.....
20	I A	12.6	13.2	2.4	.....
21	I A	7.0	21.9	1.4	.....
22	II A	12.8	14.4	2.8	22
23	II A	10.4	10.9	2.0	33
24	II A	15.4	7.9	3.4	38
25	II A	16.0	12.4	4.3	25
26	II A	9.6	8.8	1.2	30
28	II A	12.5	10.3	2.5	27
29	II A	10.2	9.5	2.4	27
31	II A	7.0	11.2	1.0	37
32	II A	11.2	8.5	1.6	38
33	II A	12.4	9.3	2.6	27
34	II A	13.0	9.0	3.4	30
35	II A	17.6	10.3	5.0	23
36	II A	16.5	12.6	4.9	27
37	II A	8.0	8.4	1.0	42
183	II A	8.3	9.6	0.7	31
39	II A	11.8	7.7	1.8	30
40	III A	10.7	8.3	2.3	41
42	III A	11.9	10.8	2.8	36
43	III A	8.5	10.5	1.2	45
44	III A	8.9	10.5	1.0	45
45	III A	10.0	10.8	1.4	42
46	III A	13.7	7.6	3.0	42

* In computing all averages, data for the first and last lines were omitted.

TABLE II—*Continued*

Subject	School Grade	Average Number Fixations per Line	Average Duration of Fixations	Average Number Regressive Movements per Line	Modified Gray Score
47	III A	9.0	7.6	1.7	43
48	III A	11.0	10.5	1.7	37
49	III A	10.4	9.5	1.2	43
50	III A	9.1	12.0	1.8	32
51	III A	13.6	9.6	4.8	33
52	III A	10.8	10.7	2.4	42
53	III A	9.3	7.3	1.8	46
55	IV A	12.3	7.9	3.0	52
56	IV A	10.2	6.3	2.7	48
57	IV A	9.3	9.8	1.4	53
184	IV A	11.0	6.5	2.2	51
58	IV A	8.8	7.4	1.5	52
185	IV A	8.3	9.7	1.3	35
59	IV A	10.4	8.7	2.4	32
60	IV A	13.2	6.1	2.3	46
61	IV A	10.2	7.6	1.8	41
62	IV A	7.6	9.7	1.6	47
64	IV A	9.6	7.0	2.4	62
65	IV A	14.1	8.7	4.4	38
66	IV A	12.7	9.0	2.3	36
67	IV A	8.8	7.3	1.1	56
68	IV A	7.6	7.2	0.3	48
69	IV A	10.6	7.8	1.9	47
70	V	8.5	7.5	1.3	53
72	V	10.7	6.7	1.6	51
73	V	5.6	6.0	1.1	62
74	V	9.0	8.1	2.0	55
75	V	8.7	6.9	1.7	58
76	V	6.7	7.3	0.6	62
77	V	11.3	8.4	2.3	47
78	V	11.5	7.0	1.7	53
186	V	5.9	8.2	0.6	56
79	V	8.5	7.0	1.6	63
80	V	9.6	6.9	1.5	51
81	V	8.2	6.4	1.4	56
82	V	9.7	6.4	0.4	57
83	V	8.8	6.0	0.9	53
84	V	7.4	7.8	1.1	60
85	V	8.3	7.9	1.3	45
86	VI A	8.9	7.9	1.1	62
87	VI A	9.4	7.5	1.0	53
88	VI A	10.2	6.0	2.6	61
89	VI A	7.7	8.4	1.0	55
90	VI A	8.1	7.7	1.2	47
91	VI A	8.8	8.0	1.0	62
92	VI A	9.8	6.8	2.1	47
93	VI A	8.1	7.8	1.6	56
94	VI A	8.9	6.8	1.4	61

TABLE II—*Continued*

Subject	School Grade	Average Number Fixations per Line	Average Duration of Fixations	Average Number Regressive Movements per Line	Modified Gray Score
95	VI A	7.1	7.1	0.8	61
96	VI A	8.8	7.5	1.8	58
97	VI A	8.7	7.1	1.0	60
98	VI A	9.3	6.2	0.8	67
99	VI A	9.0	7.8	1.0	61
100	VI A	9.4	7.6	1.4	66
101	VI A	9.3	6.3	3.0	66
102	VI A	8.5	6.7	1.0	71
103	VI A	10.2	7.1	2.4	51
104	VI A	11.2	6.2	2.1	62
105	VII	8.2	7.0	2.4	
106	VII	7.4	8.0	1.6	
107	VII	7.0	6.2	0.8	
108	VII	8.2	8.2	0.6	
109	VII	9.8	6.9	2.0	
110	VII	11.2	5.7	2.8	
111	VII	8.4	6.5	1.4	
112	VII	9.4	7.2	2.6	
113	F	9.2	6.8	1.4	
114	F	10.8	5.5	2.6	
115	F	8.4	7.0	2.0	
116	F	9.8	7.4	2.0	
117	F	7.6	7.2	1.2	
118	F	8.2	6.2	1.2	
119	F	9.0	6.1	1.0	
120	F	14.2	5.1	5.6	
121	F	7.4	6.4	0.4	
122	F	8.6	6.2	1.2	
123	F	9.2	7.7	1.8	
124	So	7.4	8.1	1.2	
125	So	8.8	6.1	2.2	
126	So	7.6	6.8	1.4	
127	So	10.4	5.4	1.4	
128	So	9.0	5.1	1.7	
129	So	7.8	6.8	1.4	
130	So	7.8	7.7	0.4	
131	So	10.6	6.4	3.0	
132	So	8.6	6.9	2.2	
133	So	10.8	6.2	2.4	
134	So	7.4	7.0	1.4	
136	J	8.8	6.4	2.4	
137	J	8.0	7.2	0.4	
138	J	8.8	6.1	0.8	
139	J	7.8	6.3	1.4	
140	J	7.2	5.7	1.2	
141	J	10.2	6.2	1.8	
142	J	6.8	7.5	1.2	

TABLE II—*Continued*

Subject	School Grade	Average Number Fixations per Line	Average Duration of Fixations	Average Number Regressive Movements per Line	Modified Gray Score
143	J	8.0	7.4	1.0	
144	J	7.3	7.4	0.5	
145	J	6.0	8.1	0.0	
155	Se	12.0	5.9	4.0	
156	Se	6.6	7.3	0.6	
157	Se	6.3	5.7	1.0	
158	Se	7.8	6.7	0.4	
159	Se	10.8	6.5	2.2	
160	Se	9.4	6.4	1.8	
161	Se	10.4	6.6	3.0	
162	Se	5.4	7.6	1.4	
163	Se	9.4	6.8	0.8	
167	Col	8.8	7.2	1.3	
168	Col	8.0	7.1	1.0	
169	Col	7.8	7.7	0.8	
170	Col	8.4	6.7	1.4	
171	Col	8.4	6.8	0.6	
172	Col	8.8	7.0	2.0	
173	Col	8.0	7.4	1.6	
174	Col	6.0	9.1	0.6	
175	Col	6.4	8.6	0.6	
178	Col	9.0	7.9	1.0	
179	Col	8.0	7.0	1.4	

cult; consequently two somewhat easier selections were used for them. The fact that the paragraphs used with the pupils in the first grade were somewhat easier would tend to reduce the steps in the growth curves between the first and second grades by just that amount. Whatever small error is introduced by the use of different materials tends, therefore, to minimize rather than exaggerate the apparent difference between the first and second grades. Plate III shows the selections used by the first grade, while Plate IV shows the paragraphs read by all other subjects.

All of the growth curves in this investigation are based on the reading of the same selections, with the exception of the first-grade pupils, as has been previously mentioned. The writer has encountered the suggestion that if instead of using identical materials, the subjects had been given selections which represented equal difficulty for each group, the character of the growth stages would have been different. This is undoubtedly true. However, such a method would have covered up the very element which the investigation was designed to study. It is

PLATE III

One day a red hen found a little wheat seed. She said to the dog, "Will you plant my wheat seed?" The dog said, "No, I will not plant your little wheat seed." The hen said to the pig, "Will you plant my wheat seed?" The pig said, "Yes, I will plant your seed."

A boy had a little dog. One day the dog ran into the woods. The boy ran after the dog. He wanted the little dog to go home. But the dog would not go home. The little boy said, "I cannot go home without my dog." Then he began to cry.

Selections read by first-grade subjects—oral selection, above; silent selection, below.

PLATE IV

This naughty dog likes to steal bones. When he steals one he hides it where no other dog can find it. He has just stolen two bones, and you must take your pencil and make two short, straight lines, to show where they are lying on the ground near the dog. Draw them as quickly as you can, and then go on.

This man is an Eskimo who lives in the far north where it is cold. There has just been a big storm, and all the ground is white with snow. The man has been walking and has made many footprints in it. With your pencil quickly make four of these in the snow just behind him.

One night Peter went to bed early. It was not dark. The bright moon shone in at the window. Peter could see everything in the room. All at once he heard a noise. Peter opened his eyes. He saw that the room had grown dark. Something was outside the window.

Tap, tap, came a noise at the window. "What is it?" called Peter. "It is I, Peter. Come to the window." Peter climbed out of bed and went to the window. There he saw a bird. This bird was so large that his eyes were as big as saucers.

"Hello, Peter," said the bird. "Hello," said Peter. "Who are you?" "I am a Bird, Peter. I have come to take you to the moon. I heard your father say that birds cannot fly to the moon. But he forgot about fairy birds. I am the King of the Fairy Birds."

Selections read by all subjects above first grade—oral selection, above; silent selection, below.

a principle of experimental technique that all elements should be kept as constant as possible except the one variable which the investigator desires to measure. If in this investigation materials of different degrees of difficulty had been used it would have been impossible to determine from the results which differences were due to type of selection and which to maturity of reading habits. The use of the same material throughout, above the first-grade level, was purposely planned in order that the variations in eye-movements might be indicative of only one factor—maturity of reading habits. The effect of materials of different degrees of difficulty was tested, however, and will be reported in another monograph.

The directions given to the subjects were to "read this story as you ordinarily do, to find out what it is about." Judging from the general attitude and behavior of the children, they did read it in their natural manner and showed no confusion due to the apparatus. Contrary to what was expected, the first-grade pupils were almost as easy to photograph as the older pupils. In fact, they seemed much less concerned about the apparatus than some of the high-school boys who showed great interest in the mechanical devices. The first-grade pupils did not sit as still while reading, but this was to be expected. In a few cases the amount of head movement made parts of the film record difficult to plot accurately, while occasionally a record had to be discarded altogether. The average time for taking the photograph, from the time the child was seated before the camera until he was up again, was less than five minutes. There was little time, therefore, for discomfort or nervousness due to the mechanical operation of the apparatus. Since all records were taken during the last month of the school semester, the results represent achievement at that period of the school year.

In all statistical data throughout the study the first and last lines of the selections are omitted, because experience has shown that the reading of these lines is frequently abnormal. Throughout this part of the study the length of line is kept constant, being 3.5 inches for all paragraphs.

The materials of this chapter will be presented in the following order: first, the growth stages in the silent-reading process; second, growth stages in oral reading; third, the relationship between growth in oral reading and scores on the Gray Oral Reading Paragraphs; fourth, the relationship between growth in silent reading and scores on the Monroe Silent Reading Test; and fifth, a comparison of the growth curves in silent reading for the different elements studied.

GROWTH IN SILENT READING

Development in span of recognition.—If the reader will note the number of seconds required to read silently the series of letters, *a – x – w – o – b – r – y – n – q – h*, and will then note the time required for reading the series of four-letter words, *nine – cars – book – lamp – look – slow – sick – boys – ball – with*, he will find that it requires little, if any, more time to read the ten words than to read the ten letters. The reason for this is that a mature reader does not look at the individual letters making up a word but, rather, takes in a whole word at a single preception just as easily as a single letter. The size and character of his recognition-span are such that it is as easy to perceive a word as a letter. If the words are arranged in a meaningful order, as in a sentence, it becomes even easier to read ten words than to read unrelated letters. One of the characteristics of a mature reader is the possession of a span of recognition which enables him to recognize as a single unit not only a word of four letters but even a group of words. The recognition unit in reading is defined by the amount of printed material that can be recognized in a single span of attention. If the reader will turn to Plates I and II it will be seen that the mature reader in Plate II was able to recognize the nine words in the second line with 4 eye-fixations, while in the fifth line only 3 fixations were necessary to recognize the same number of words. This subject has a wide recognition-span. The first-grade pupil shown in Plate I, on the other hand, has a very narrow recognition-span. For this subject 19 fixations were required in reading the second line, while the fifth line required 32 fixations. The difficulty which this pupil experiences is that he has not yet attained a sufficient degree of familiarity with printed words to be able to recognize them without a minute analysis. In reading the three words "cannot go home" in the fifth line 20 fixations were required. If the serial order of the fixations is followed from number 9 to number 27 it will be noticed that this pupil simply oscillated back and forth, examining the words in great detail. This oscillating reaction is a symptom of mental confusion, which shows that the pupil is not grasping the material in large units but rather is carrying on a more or less detailed analysis which is quite the opposite of the ordinary process of reading. Before this pupil can become a mature reader it will be necessary for him to develop a span of recognition which is much wider and which will resemble that of the college student in Plate II.

A measure of the span of recognition may be obtained, therefore, from the average number of fixations per line required in reading. As

the number of fixations per line decreases, the width of the recognition-span increases. The development of this element during the school period will be studied by ascertaining the decrease in the grade medians for the average number of fixations per line.

The average number of fixations per line and the school grade for each of the one hundred and seventy-nine subjects from whom silent reading records were secured are given in Table III, which should be

TABLE III

GROWTH STAGES FOR AVERAGE NUMBER OF FIXATIONS PER LINE IN SILENT READING

AVERAGE NUMBER OF FIXATIONS PER LINE	SCHOOL GRADE												TOTAL
	I B	I A	II	III	IV	V	VI	VII	F	So	J	Se	Col	
3.0–3.9	....	....	....	....	....	....	....	....	....	....	....	....	1	1
4.0–4.9	....	....	....	....	....	....	....	....	1	2	6	1	2	12
5.0–5.9	....	....	....	....	....	2	2	1	1	5	7	3	4	25
6.0–6.9	....	....	2	1	7	7	5	4	3	....	3	5	6	43
7.0–7.9	....	1	....	3	2	2	8	....	3	4	3	3	....	29
8.0–8.9	....	....	....	4	3	3	3	3	2	....	....	....	....	18
9.0–9.9	....	....	3	4	1	1	....	....	1	1	....	....	....	11
10.0–10.9	....	....	6	2	1	....	1	....	....	....	....	....	....	10
11.0–11.9	....	1	3	1	....	1	....	....	....	....	....	....	....	6
12.0–12.9	....	....	1	....	1	....	....	....	....	....	....	....	....	2
13.0–13.9	....	1	2	....	....	....	....	....	....	....	....	....	....	3
14.0–14.9	1	2	....	....	....	....	....	....	....	....	....	....	....	3
15.0–15.9	....	2	....	....	....	....	....	....	....	....	....	....	....	2
16.0–16.9	....	2	....	....	....	....	....	....	....	....	....	....	....	2
17.0–17.9	1	....	....	....	....	....	....	....	....	....	....	....	....	1
18.0–18.9	4	....	....	....	....	....	....	....	....	....	....	....	....	4
19.0–19.9	1	....	....	....	....	....	....	....	....	....	....	....	....	1
20.0–up	2	3	1	....	....	....	....	....	....	....	....	....	....	6
Total	9	12	18	15	15	16	19	8	11	12	19	12	13	179
Median	18.6	15.5	10.7	8.9	7.3	6.9	7.3	6.8	7.2	5.8	5.5	6.4	5.9	.....

read as follows: One subject, a college student, made an average number of fixations per line falling in the interval of 3.0–3.9; twelve subjects made averages falling in the interval of 4.0–4.9, and of this group one was a Freshman, two were Sophomores, six were Juniors, one was a Senior, and two were college students, etc. The medians for each school grade are given in the last line of the table, the median for Grade I B being 18.6, for Grade I A 15.5, for the second grade 10.7, etc. Figure 1 shows the growth curve for these grade medians. From this figure it is evident than there is a very rapid growth in span of recognition up to the end of the fourth grade; beyond this the rate of growth is less pronounced,

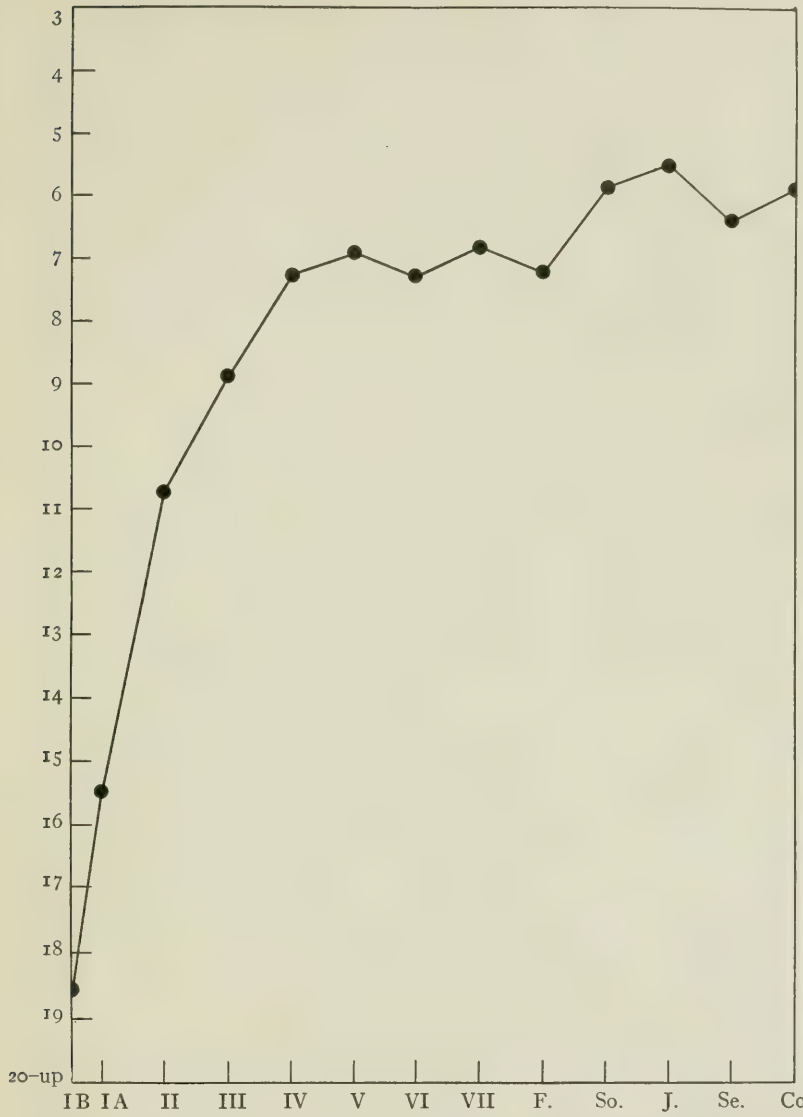


FIG. 1.—Growth stages for average number of fixations per line in silent reading. School grade shown on horizontal axis; average number of fixations per 3.5 inch line shown on vertical axis.

with the exception of a notable increase during the Sophomore and Junior years in the high school.

The reader should note that the nature of the growth curve for this, as for other elements of reading, is biased by the type of training which the school has given. It cannot be assumed that the particular curves which appear are necessarily the most desirable forms of growth or even the natural forms. Different emphases upon the various elements at different levels of the school period might produce a considerable change in the rate of growth at those points. The growth curves shown represent the stages of development of the various elements of reading under the present school conditions. The variations of individual cases from the grade medians as exhibited in Table III show that some pupils take a very different route in their progress toward maturity

A careful examination of the growth curve in Figure 1 will reveal three definite tendencies: first, a very rapid growth during the first four school years; second, a plateau extending through the fifth, sixth, seventh, and Freshman years; and third, a second rise during the middle high-school years. It is clear from the figure that the chief development in span of recognition comes early in the school course. The child proceeds a long distance toward maturity in this element before he enters the fifth grade. While a small increase occurs during the fifth grade, it is only one-fourth as great as the increase during the preceding year. It is a significant fact that the fourth grade marks the turning-point in this element. The radical change in the curve of growth at the end of the fourth grade demands an explanation, either in terms of the element itself or in terms of the school reading situation. It is clear that the limit of growth in span of recognition has not been reached in the fourth grade. The later rise in the curve shows that the high-school medians above the Freshman year exceed the highest score up to the fourth-grade level. If mature habits of reading require a further growth in span of recognition, why does not the curve make a continuous rise up to the highest median?

A possible answer to this question is found in the nature of the school work during the fifth, sixth, seventh, and Freshman years. Up to the end of the fourth grade the principal emphasis of the school is placed upon the subject of reading. The reading which the child does is more or less of the same type and for the same purpose. Beginning in the fifth grade there is an increasing amount of time given to a variety of content subjects. The character of the demand upon the child's reading habits changes. A greater emphasis is placed upon a type of study

which is quite different from the former reading which, for the greater part, was concerned with materials easy of comprehension. As long as the reading is of the same general character, a regular increase in the elements of the process would be expected. When the purpose of reading is changed and the different types of material are taken up, the attention of the pupil must be centered on these new variations, while the old elements are in a measure neglected. For example, when a pupil is given a text in algebra or foreign language his previous habit of using a wide recognition unit with simple story material is entirely inadequate for the mastery of this new content. Meanings in algebra and foreign language are not as clear as meanings in descriptive geography or fiction. The change from the formal subjects of the elementary period to the varied content of the high-school course seriously interrupts the development of the span of recognition, the extent of the interference being disclosed by the plateau in Figure 1.

The rise in the curve during the Sophomore and Junior years suggests that the pupil has by that time become adjusted to the various types of new material and to the new study habits required for high-school work. The heavy reading requirements of literature and history stimulate the further development of a wide span of recognition. The drop in the Senior year may be accidental or it may be the compensating result of some other type of adjustment. In any case, the median remains at a higher level than during the period of the plateau.

A study of eye-movement records reveals the fact that the number of fixations per line varies in the reading of an individual subject. The size of the recognition-span is evidently greater at some points than others. Evidence is at hand which indicates that the relative difficulty of the material read or the particular aim of the reader has a direct influence upon the width of the span of recognition. It was for the purpose of eliminating such variable factors that the same selections and the same directions for reading were used throughout this experiment. However, even in the reading of a single selection the number of fixations per line varies. If a subject reads a complete selection with an average of 8 fixations per line, but reads one of the lines with 4 fixations, the question arises as to whether his span of recognition is equal to one-eighth or one-fourth of the length of the line. The answer to the question involves a definition of terms. The average number of fixations per line gives a measure of the normally used recognition-span. This normal span may be considerably less than the possible maximum. In certain portions of a selection a variety of causes may co-operate in

making the reading especially easy or difficult, with a corresponding reduction or increase in the number of fixations. The element measured by the growth curve in Figure 1 is the average, normally used span of recognition. For a study of reading, this normal span is of greater significance than the possible maximum span. The recognition unit which has been frequently measured in experimental psychology by a simple tachistoscopic apparatus has been the maximum recognition unit. The reader should not confuse this measure with that secured by finding the average number of fixations per line. The former shows the limits of the recognition unit; the latter shows the normal recognition-span used in reading.

In the total complex process of reading the size of the average recognition-span is a very significant element. The ultimate goal of reading is to secure meaning from the printed page in large thought units. The smallest possible unit of thought is the word, while the most common units are phrases. As long as a reader is unable to grasp these thought elements in a single recognition his mental processes are interrupted by the necessity of piecing together the material to make up meaningful elements. It is perfectly evident from an examination of Plate I that this first-grade reader is not dealing with thought units, since a large part of her effort is taken up with an analysis of the words. Until she reaches the stage of maturity where she can recognize the word or phrase as a whole and in an automatic manner, she will not be able to give her full attention to the meaning. The college student in Plate II has a recognition-span which is wide enough to deal with whole thought units, making possible a type of reading in which interpretation is the dominant element in consciousness with only a minimum of attention to the recognition process. The immature reader must piece together his small units of recognition with much the same difficulty which a pedestrian would experience in getting a general idea of the geography of a city by walking up and down the streets between the sky-scrapers; while the mature reader has so far mastered his recognition unit that his interpretation of meaning could be compared with a bird's-eye view of the city from an airplane. The significance of a wide recognition-span is that it relieves the mind of a detailed form of word-analysis and makes possible the focusing of consciousness upon the process of interpretation.

Growth in rate of recognition.—It has just been shown that the width of the span of recognition increases as reading habits become more mature. If the reader will turn again to Plates I and II he will see that

the college student not only covered a large unit of material at each fixation but that the average duration of her fixations was considerably shorter than that of the first-grade pupil. The rate of recognition, regardless of the size of the recognition unit, becomes, therefore, an important factor in reading. The growth in rate of recognition, as measured by the average duration of fixations, is shown in Table IV and Figure 2. Table IV gives the average duration of fixations in twenty-

TABLE IV

GROWTH STAGES FOR AVERAGE DURATION OF FIXATION PAUSES IN SILENT READING

AVERAGE DURATION OF FIXATION PAUSES IN TWENTY-FIFTHS OF A SECOND	SCHOOL GRADE													TOTAL
	I B	I A	II	III	IV	V	VI	VII	F	So	J	Se	Col	
3.0–3.9	....	....	....	....	....	....	....	....	....	....	....	....	....	.....
4.0–4.9	....	....	....	....	....	....	....	....	....	1	2	....	1	4
5.0–5.9	....	....	....	....	2	6	11	4	5	4	12	5	3	52
6.0–6.9	....	1	1	3	8	8	7	3	4	6	5	6	8	60
7.0–7.9	....	....	4	5	3	2	1	1	1	....	....	....	....	17
8.0–8.9	....	....	3	4	1	....	....	....	....	....	....	1	1	10
9.0–9.9	....	2	7	3	1	....	....	....	1	1	....	....	....	15
10.0–10.9	1	4	1	....	....	....	....	....	....	....	....	....	....	6
11.0–11.9	....	3	1	....	....	....	....	....	....	....	....	....	....	4
12.0–12.9	....	....	1	....	....	....	....	....	....	....	....	....	....	1
13.0–13.9	2	....	....	....	....	....	....	....	....	....	....	....	....	2
14.0–14.9	1	....	....	....	....	....	....	....	....	....	....	....	....	1
15.0–15.9	....	1	....	....	....	....	....	....	....	....	....	....	....	1
16.0–16.9	1	....	....	....	....	....	....	....	....	....	....	....	....	1
17.0–17.9	2	....	....	....	....	....	....	....	....	....	....	....	....	2
18.0–18.9	....	1	....	....	....	....	....	....	....	....	....	....	....	1
19.0–19.9	1	....	....	....	....	....	....	....	....	....	....	....	....	1
20.0–up	1	....	....	....	....	....	....	....	....	....	....	....	....	1
Total	9	12	18	15	15	16	19	8	11	12	19	12	13	179
Median	16.5	10.8	9.1	7.9	6.7	6.3	5.9	6.0	6.1	6.2	5.6	6.2	6.3	.....

fifths of a second and the school grade for each subject. It shows that the median of the average duration of fixations for Grade I B is 16.5 twenty-fifths of a second; for Grade I A 10.8 twenty-fifths; for the second grade 9.1 twenty-fifths, etc. Figure 2 presents these grade medians graphically. The curve shows a rapid increase in rate of fixation up to the end of the fourth grade, with a continued but smaller increase on through the sixth grade. From that point no higher median is observed with the exception of that of the high-school Juniors. The median for adults is the same as that for the fifth grade.

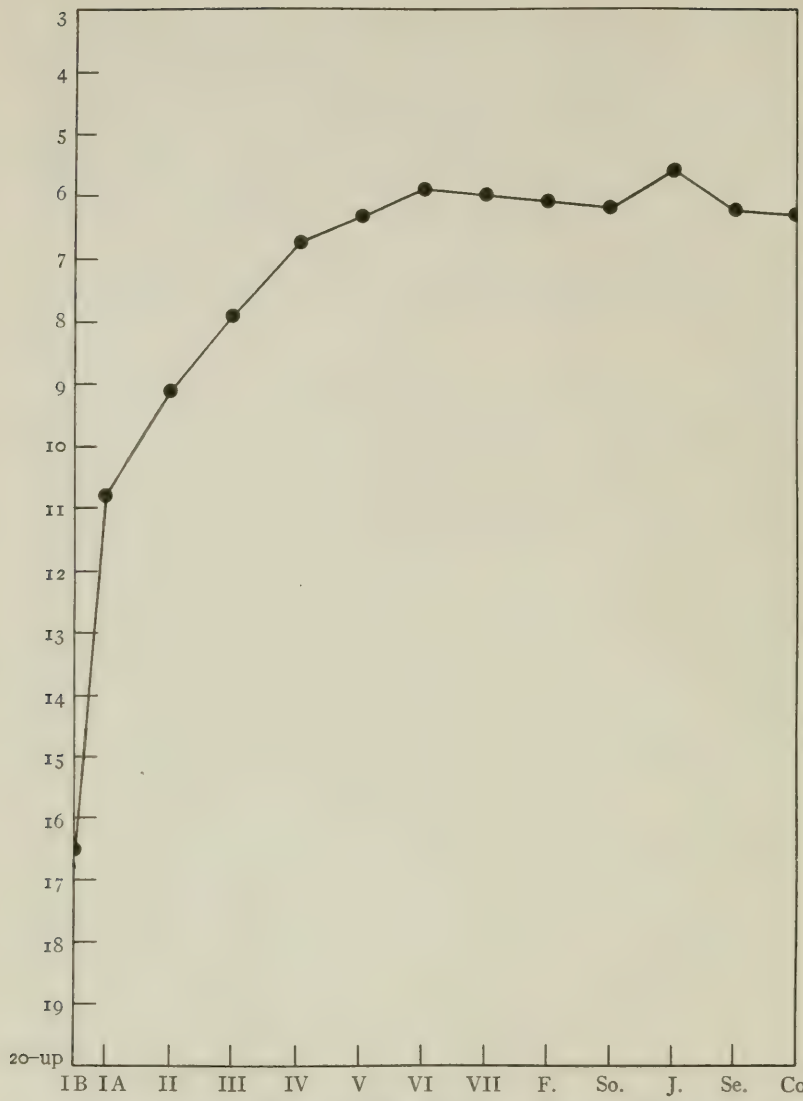


FIG. 2.—Growth stages for average duration of fixation pauses in silent reading. School grade shown on horizontal axis; average duration of fixation pause shown on vertical axis.

These medians show that growth in speed of recognition proceeds in quite a different manner from growth in span of recognition. The fact, as exhibited by Table IV, that fifty-two subjects were able to reach an average fixation time of 5 twenty-fifths of a second, while only four subjects were able to make a shorter average indicates that the limit of fixation time is about 5 twenty-fifths. Out of the one hundred and ten subjects in the grades above the fourth, only nine failed to raise their average fixation time to the level of 6 twenty-fifths of a second. From these data it is evident that a speed of fixation of from 5 to 6 twenty-fifths of a second satisfies the demands of maturity in reading. It is also evident that it is entirely possible to reach this level by the end of the fourth grade. Rate of recognition, therefore, is one element of reading which can be carried to the level of maturity very early in the school period. The significance of the duration of fixations will be discussed in greater detail in the following chapters, where illustrative records of individual cases will be introduced.

Rhythmic progression along printed lines.—The third element of reading, for which a growth curve was determined, is that of rhythmic progression along the printed lines. In the eye-movement record of a mature reader it will be seen that the eye progressed across the lines with a rhythmic swing, making approximately the same number of fixations per line with few or no backward movements. In contrast with this the immature reader moves forward a few fixations, then backward to refixate upon some word which was not clearly recognized, then forward and soon back again in the reverse direction. This oscillation of eye-movements back and forth along the lines indicates that the reader is confused and is unable to proceed in regular order along the lines. This irregularity in reading procedure can be measured by the average number of regressive movements per line. Since regular, rhythmic progress along the lines of print is possible only through the development of habits of sure recognition, the number of regressive movements required in reading furnishes an index of another element of the recognition process.

The relationship between average number of regressive movements per line and school grade is exhibited by the data in Table V and the curve in Figure 3. Table V, which should be read in the same manner as Table III, shows that the median pupil in Grade I B made an average of 5.1 regressive movements per line; in Grade I A an average of 4.0; in Grade II an average of 2.3, etc. The curve of growth in Figure 3 makes a very rapid rise during the first four grades; a notable lack of

progress during Grades V, VI, and VII; with a second rise during the first two high-school years. In general form the curve is similar to that for span of recognition. The fact that all the medians for the grades beyond the seventh are distinctly higher than any medians below that point indicates that the development of regular, rhythmic eye-movements is one element of reading toward which high-school and college training directly contributes. It also shows that the possibility of increased efficiency at the upper levels of the school period is consider-

TABLE V

GROWTH STAGES FOR AVERAGE NUMBER OF REGRESSIVE MOVEMENTS PER LINE IN SILENT READING

AVERAGE NUMBER OF REGRESSIVE MOVEMENTS PER LINE	SCHOOL GRADE													TOTAL
	I B	I A	II	III	IV	V	VI	VII	F	So	J	Se	Col	
0.0–0.4	....	....	....	1	....	3	....	1	1	4	7	5	7	29
0.5–0.9	....	1	1	1	4	2	5	....	5	5	8	3	5	40
1.0–1.4	....	....	2	4	4	6	3	3	2	2	3	2	....	31
1.5–1.9	....	....	2	3	2	1	7	2	1	....	1	2	1	22
2.0–2.4	....	....	6	3	3	1	3	2	1	1	....	....	....	20
2.5–2.9	....	1	2	1	1	1	....	....	1	....	....	....	....	7
3.0–3.4	....	3	2	1	1	2	1	....	....	....	....	....	....	10
3.5–3.9	2	1	2	1	....	....	....	....	....	....	....	....	....	6
4.0–4.4	1	3	....	....	....	....	....	....	....	....	....	....	....	4
4.5–4.9	1	....	....	....	....	....	....	....	....	....	....	....	....	1
5.0–5.4	2	....	....	....	....	....	....	....	....	....	....	....	....	2
5.5–5.9	1	....	....	....	....	....	....	....	....	....	....	....	....	1
6.0–6.4	....	1	....	....	....	....	....	....	....	....	....	....	....	1
6.5–6.9	1	2	....	....	....	....	....	....	....	....	....	....	....	3
7.0–7.4	1	....	....	....	....	....	....	....	....	....	....	....	....	1
7.5–7.9	....	....	....	....	....	....	....	....	....	....	....	....	....	.....
8.0–8.4	....	....	....	....	....	....	....	....	....	....	....	....	....	.....
8.5–up	....	....	1	....	....	....	....	....	....	....	....	....	....	1
Total	9	12	18	15	15	16	19	8	11	12	19	12	13	179
Median	5.1	4.0	2.3	1.8	1.4	1.3	1.6	1.5	1.0	0.7	0.7	0.7	0.5	.....

ably greater for this habit than for that of duration of fixations which was plotted in Figure 2.

There are several types of regressive movements which are produced by as many different causes. The most common regressive movement occurs at the beginning of a line where the return sweep of the eye has failed to carry the fixation back to the first word in the line and an additional regressive movement is required to make the initial part of the line clear. This type of regressive movement persists up to the more mature stages of reading.

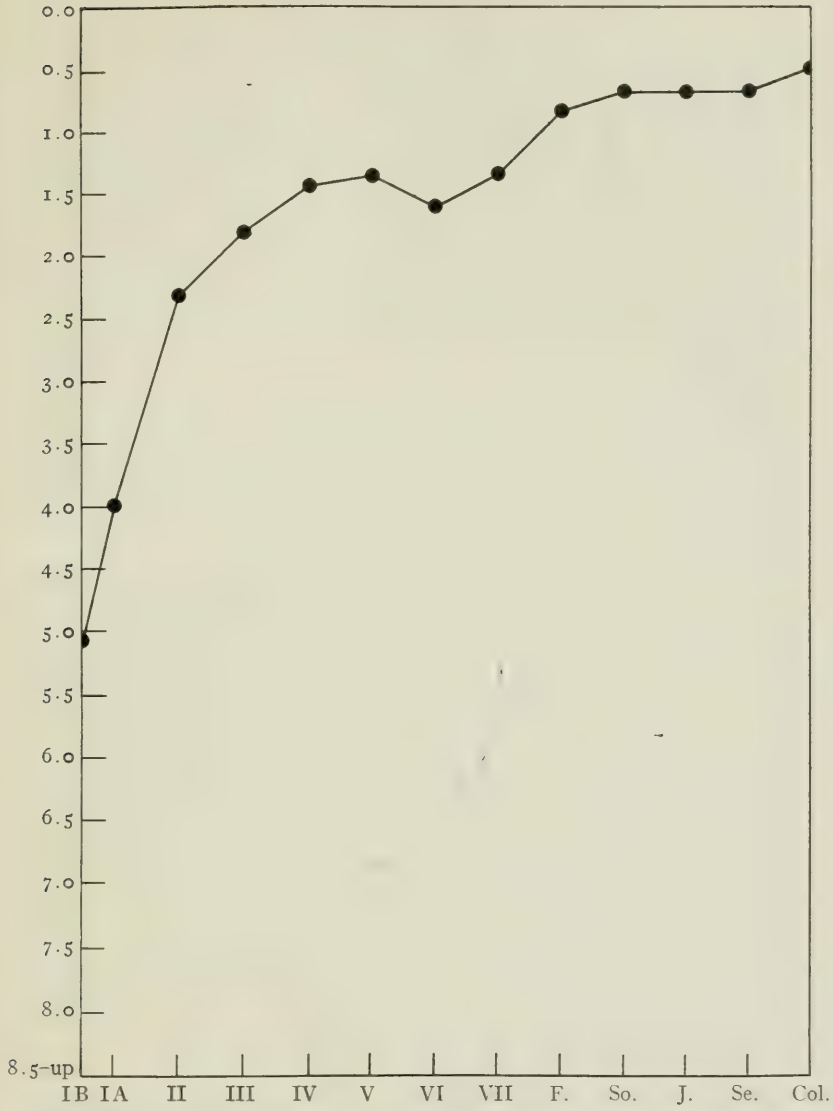


FIG. 3.—Growth stages for average number of regressive movements per line in silent reading. School grade shown on horizontal axis; average number of regressive movements per line shown on vertical axis.

A second type of regressive movement appears in the records of a number of mature readers who continually try to make as few fixations per line as possible. In their effort to grasp a larger unit in a single eye-fixation they occasionally overreach their maximum span and find it necessary to make a backward eye-movement to clarify the meaning.

While in such cases regressive movements are characteristic of rather mature reading, the most mature subjects have reached a stage where they do not overreach their capacity and consequently have few, if any, regressive movements. The presence of a few regressive movements caused by an effort to attain a wider recognition unit may be the necessary accompaniment of certain stages of growth in the span of recognition.

A third type of regressive movement is caused by lack of word-knowledge. In the paragraphs used in this study, even the comparatively simple words in the first-grade selection caused many regressive movements for some of the pupils. Previous investigations have shown that high-school and adult subjects will react in the same manner provided sufficiently difficult words are introduced.

A fourth type of regressive movement consists of a random oscillation of the eye with no apparent plan on the part of the reader. This type of behavior has been appropriately named a "confusion period." The reader fails to get a clear perception of the meaning and accordingly sets up a series of eye-fixations which move back and forth over the area, causing difficulty. This type of eye-movement may occur in the beginning stages of reading where it shows lack of ability to grasp proper units of recognition, and it may occur in the later stages of reading where the reading gives way to analysis of some kind. Regressions in the latter case are signs of disintegration rather than immaturity.

Four kinds of regressive movements have been described, all of which are characteristic of more or less immature reading. The curve of growth in Figure 3 shows clearly that the elimination of these regressive movements is not easily accomplished, but that growth continues up to the highest level of maturity.

GROWTH IN ORAL READING

The three growth curves which have just been exhibited were based upon silent-reading records. It will be a matter of interest to determine whether the growth curves as exhibited by oral reading are in any respect different. Accordingly, a series of growth curves will be presented based upon the oral reading records of one hundred and sixty-four subjects.

Table VI and Figure 4 show the relationship between average number of fixations per line and school grade. The median for the I B grade is 16.0; for the I A grade, 14.5; for the second grade, 12.0, etc. The curve in Figure 4 shows a rapid development of this element during the fourth grade, followed by a rapid increase during the fifth grade. Beyond the fifth grade the curve shows no pronounced increase except during the Sophomore and Junior years. The broken line in

TABLE VI

GROWTH STAGES FOR AVERAGE NUMBER OF FIXATIONS PER LINE IN ORAL READING

AVERAGE NUMBER OF FIXATIONS PER LINE	SCHOOL GRADE													TOTAL
	I B	I A	II	III	IV	V	VI	VII	F	So	J	Se	Col	
3.0–3.9														
4.0–4.9														
5.0–5.9						2						1		3
6.0–6.9						1					2	2	2	7
7.0–7.9		1	1		2	1	2	2	2	5	3	1	1	21
8.0–8.9			2	2	3	6	8	3	3	2	4		7	40
9.0–9.9			1	3	2	3	6	2	4	1		2	1	25
10.0–10.9	1	1	2	4	4	1	2		1	3	1	2		22
11.0–11.9	1	2	2	2	1	2	1	1						12
12.0–12.9		2	3		2							1		8
13.0–13.9	2		1	2	1									6
14.0–14.9	1	2			1				1					5
15.0–15.9		3	1											4
16.0–16.9	1	2	2											5
17.0–17.9			1											1
18.0–18.9	3													3
19.0–19.9														
20.0–up	2													2
Total	11	13	16	13	16	16	19	8	11	11	10	9	11	164
Median	16.0	14.5	12.0	10.4	10.3	8.7	8.9	8.7	9.1	8.3	8.0	9.3	8.4	

Figure 4 reproduces the curve for the average number of fixations per line in silent reading. A comparison of the two curves shows that a wider recognition-span is maintained throughout in silent reading, except during the first grade. No significance should be attached to the crossing of the two curves just above the first grade, for two reasons. The first is the fact that the distribution of the individual averages during the first grade shows such a wide variation that the significance of the exact median is small. The second reason for attaching no special importance to the crossing of the curves is the fact that supplementary data indicate that the oral medians in Grades I B and I A should be

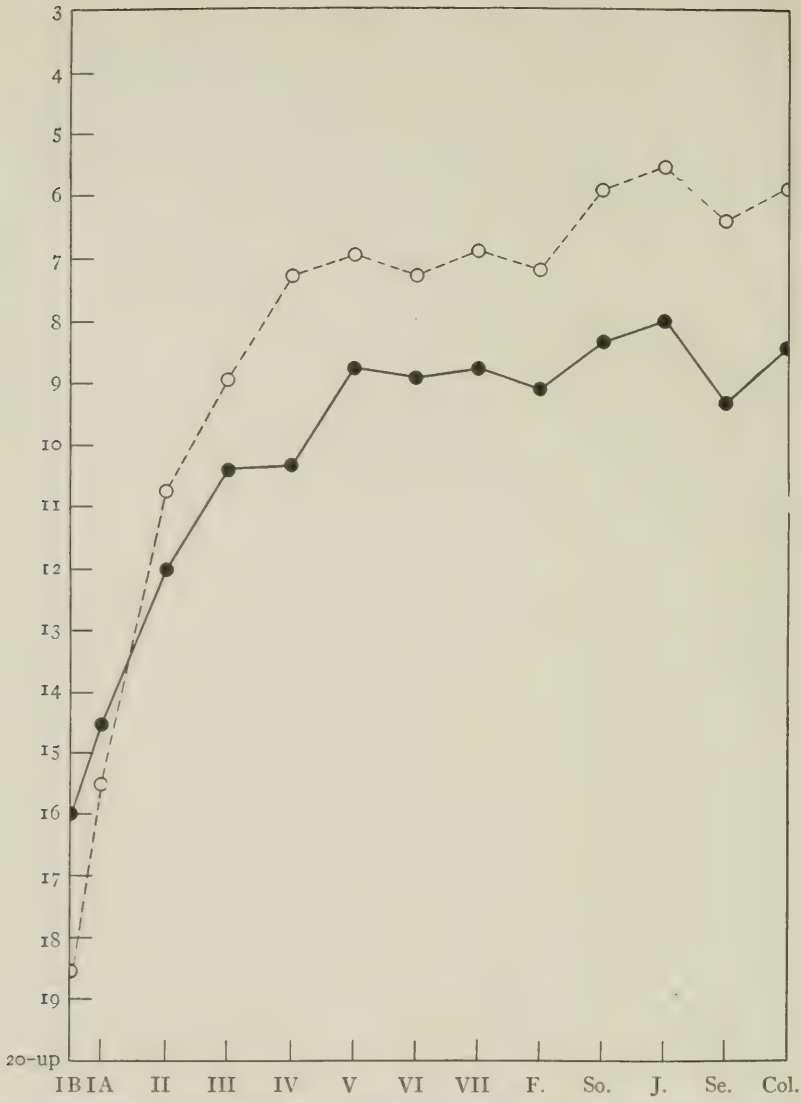


FIG. 4.—Growth stages for average number of fixations per line in oral reading. School grade shown on horizontal axis; average number of fixations per line shown on vertical axis. (Broken line reproduces corresponding silent reading curve.)

considerably lower than the particular medians shown in Figure 4. For example, records taken five weeks earlier of fifteen pupils from these same groups showed a median number of fixations per line for oral reading of 22 in Grade I B, and of 17 in Grade I A. The further fact that some of the children had read the "Little Red Hen" story shortly before the test may be another reason for the higher curve in oral reading at this point.

The principal significance of a comparison of the oral and silent curves lies in the fact that throughout the grades, at least above the first, the silent-reading process makes possible or stimulates broader recognition units, while in oral reading the use of these wide fixations is inhibited. This furnishes evidence that there is a fundamental difference between the oral- and silent-reading processes. In oral reading some attention must be given to each word as it is pronounced. The necessity, on the part of the voice, of dealing with word units evidently carries over into the recognition habits, causing a smaller recognition-span than in silent reading.

With the exception of Grades I and IV the oral curve follows the same general trend as that of the silent process, only at a lower level. The relatively small social importance of oral reading at the higher levels would lead one to expect to find no further increases after the elementary period. The small increase during the high-school period may be due to the particular character of the school's training, or it may be due to the presence of some elements of transfer from the silent process.

The growth curve for average durations of fixations in oral reading is shown in Table VII and by the solid line in Figure 5. The broken line gives the corresponding curve for silent reading. With the exception of an irregularity at the third grade, the oral curve shows a rapid rise through the fourth grade, with a small tendency toward increase beyond that point.

The characteristics of the oral curves in Figures 4 and 5 are better understood if they are studied together. Figure 4 shows a rapid rise in the curve for average recognition-span during the third grade with practically no growth at all during the fourth. Figure 5 shows a slight loss in average duration of fixation in the third grade with a very pronounced increase during the fourth grade. These two grades furnish a good illustration of alternation in growth. The energies of the third grade were evidently so entirely concerned with increasing the span of recognition that the element of duration of fixation made no improvement; while the fourth grade expended its energies primarily in develop-

ing a short fixation time, with only a small increase in the size of recognition-span. A similar situation occurs in the Junior and Senior groups from the high school. These variations indicate the flexibility of the growth in different elements of the reading process. The pupils can make more than one type of adjustment in their progress toward maturity.

The fact that the grade medians for the average duration of fixations in oral reading never reach the medians for silent reading is probably

TABLE VII

GROWTH STAGES FOR AVERAGE DURATION OF FIXATION PAUSES IN ORAL READING

AVERAGE NUMBER OF FIXATIONS PER LINE	SCHOOL GRADE													TOTAL
	I B	I A	II	III	IV	V	VI	VII	F	So	J	Se	Col	
3.0–3.9	....	....	....	....	....	....	....	....	....	....	....	....	....	.....
4.0–4.9	....	....	....	....	....	....	....	....	....	....	....	....	....	.....
5.0–5.9	....	....	....	....	....	....	....	1	2	2	1	2	....	8
6.0–6.9	....	....	....	....	3	7	7	3	5	6	4	5	2	42
7.0–7.9	....	....	2	3	7	6	10	2	4	2	4	2	7	49
8.0–8.9	....	2	3	1	2	3	2	2	....	1	1	....	1	18
9.0–9.9	....	....	4	2	4	....	....	....	....	....	....	....	1	11
10.0–10.9	....	2	3	6	....	....	....	....	....	....	....	....	....	11
11.0–11.9	....	1	1	....	....	....	....	....	....	....	....	....	....	2
12.0–12.9	3	2	2	1	....	....	....	....	....	....	....	....	....	8
13.0–13.9	2	2	....	....	....	....	....	....	....	....	....	....	....	4
14.0–14.9	....	1	1	....	....	....	....	....	....	....	....	....	....	2
15.0–15.9	....	....	....	....	....	....	....	....	....	....	....	....	....	.....
16.0–16.9	....	1	....	....	....	....	....	....	....	....	....	....	....	1
17.0–17.9	....	....	....	....	....	....	....	....	....	....	....	....	....	.....
18.0–18.9	....	....	....	....	....	....	....	....	....	....	....	....	....	.....
19.0–19.9	3	....	....	....	....	....	....	....	....	....	....	....	....	3
20.0–up	3	2	....	....	....	....	....	....	....	....	....	....	....	5
Total	11	13	16	13	16	16	19	8	11	11	10	9	11	164
Median	19.2	12.8	9.8	10.1	7.7	7.2	7.3	7.0	6.7	6.6	7.0	6.5	7.5	.....

due to the retarding influence of the voice. Pronouncing the words slows down the entire process, giving the reader more time for his recognitions but establishing a habit of making longer fixations.

The growth in regularity of procedure along the printed lines, as measured by the decrease in the number of regressive movements, is shown in Table VIII and Figure 6. The curve for oral reading, as exhibited in Figure 6, is very irregular. During the first six years the decrease in regressive movements approaches the level of the silent-reading curve, but beyond this point the curve makes no conspicuous rise and remains considerably below the medians for silent reading. The

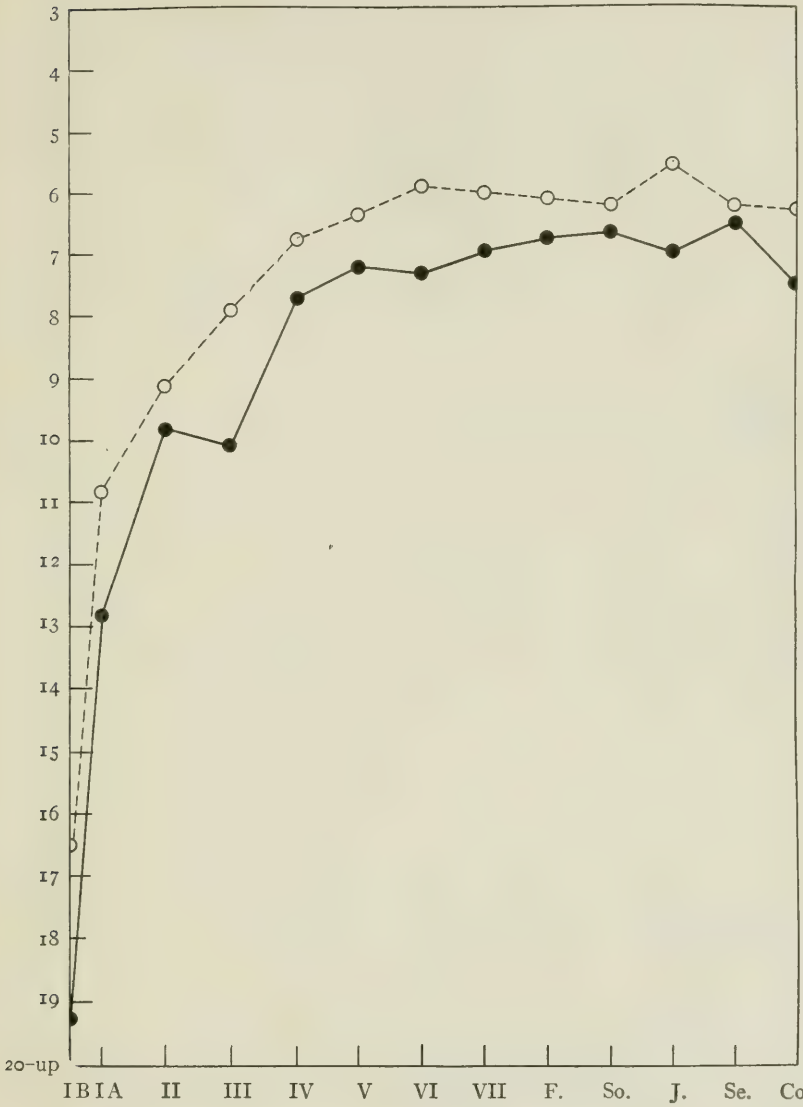


FIG. 5.—Growth stages for average duration of fixation pauses in oral reading. School grade shown on horizontal axis; average duration of fixation pause shown on vertical axis. (Broken line reproduces corresponding silent reading curve.)

notable characteristic in this curve is not its failure to show greater growth during the last six years, but rather, the high level of rhythmic eye-movement habits during the first six years. This may be due to the fact that in oral reading the reader is conscious of a demand for continuity in the process, and that the mere necessity of pronouncing the words in order also stimulates the eyes to move along in the forward direction.

TABLE VIII

GROWTH STAGES FOR AVERAGE NUMBER OF REGRESSIVE MOVEMENTS PER LINE IN ORAL READING

AVERAGE NUMBER OF REGRESSIVE MOVEMENTS PER LINE	SCHOOL GRADE													TOTAL
	I B	I A	II	III	IV	V	VI	VII	F	So	J	Se	Col	
0.0–0.4	....	....	....	....	1	1	....	....	1	1	2	1	....	7
0.5–0.9	....	....	1	....	....	3	2	2	....	....	2	2	4	16
1.0–1.4	1	2	3	4	3	5	10	1	5	5	4	2	5	50
1.5–1.9	....	....	2	4	4	5	2	1	1	1	1	1	1	23
2.0–2.4	1	4	2	2	5	2	3	2	2	3	1	1	1	29
2.5–2.9	....	....	3	1	1	....	1	2	1	....	....	....	....	9
3.0–3.4	2	2	2	1	1	....	1	....	....	1	....	1	....	11
3.5–3.9	....	3	....	....	....	....	....	....	....	....	....	....	....	3
4.0–4.4	2	1	1	....	1	....	....	....	....	....	....	1	....	6
4.5–4.9	1	....	1	1	....	....	....	....	....	....	....	....	....	3
5.0–5.4	2	1	1	....	....	....	....	....	....	....	....	....	....	4
5.5–5.9	....	....	....	....	....	....	....	....	1	....	....	....	....	1
6.0–6.4	1	....	....	....	....	....	....	....	....	....	....	....	....	1
6.5–6.9	....	....	....	....	....	....	....	....	....	....	....	....	....	.....
7.0–7.4	....	....	....	....	....	....	....	....	....	....	....	....	....	.....
7.5–7.9	....	....	....	....	....	....	....	....	....	....	....	....	....	.....
8.0–8.4	....	....	....	....	....	....	....	....	....	....	....	....	....	.....
8.5–up	1	....	....	....	....	....	....	....	....	....	....	....	....	1
Total	11	13	16	13	16	16	19	8	11	11	10	9	11	164
Median	4.4	3.1	2.5	1.8	2.0	1.4	1.4	2.0	1.5	1.5	1.1	1.4	1.2	.....

As a whole the growth curves for the three fundamental characteristics of eye-movements are not conspicuously different in oral and silent reading. The apparent difference at the first-grade level has been explained. The differences at the upper level are to be expected from the nature of the two processes. It must be kept clearly in mind, however, that the curves for the two processes are the result of the particular kind of training which the school has given. A different emphasis

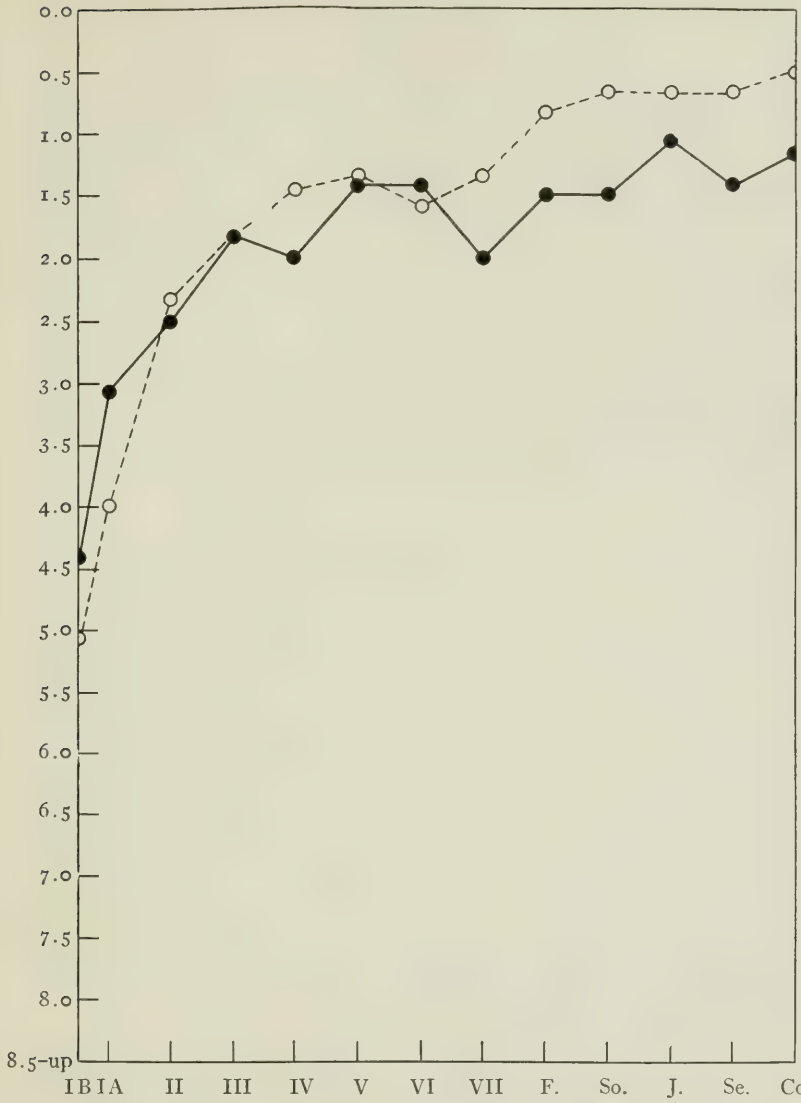


FIG. 6.—Growth stages for average number of regressive movements per line in oral reading. School grade shown on horizontal axis; average number of regressive movements per line shown on vertical axis. (Broken line reproduces corresponding silent reading curve.)

upon silent or oral reading might cause a considerable modification in the curves.

Before attempting to make further interpretations of the relation of these three types of eye-movements to progress through the school grades, the writer desires to present some facts revealing the relationship between two other series of measures. Since position in school grade is not determined by reading ability alone, other factors would certainly modify to some extent the growth curves just exhibited. A study of the development of eye-movement habits in relation to progress in reading ability as measured by some objective and standardized tests in this subject would, therefore, bring out some significant relationships. For this purpose the growth curves of the three characteristics of eye-movement habits will be shown, first, for oral reading in comparison with the scores on the Gray Oral Reading Paragraphs and, second, for silent reading in comparison with comprehension scores on the Monroe Silent Reading Test.

EYE-MOVEMENT ELEMENTS AND ACHIEVEMENT IN ORAL READING

In order to make valid comparisons with progress in oral-reading achievement, regardless of school grade, the scores on the Gray Oral Reading Paragraphs were modified so that identical scores represent equal reading ability, without reference to the school grade of the subjects. This modification is necessary because in the Gray test the standard scores are relative to the grade, average reading ability in each being assigned the same score. In order to equate the scores, Grade VI was arbitrarily taken as a standard, while the scores for the grades below were reduced as follows: Grade V reduced 5 points, Grade IV reduced 10 points, Grade III reduced 15 points, and Grade II reduced 20 points. This would mean that a score of 50 in Grade II would represent the same degree of reading achievement, before reduction, as a score of 30 in Grade VI. Such a score would accordingly be reduced to 30 for purposes of comparison.

Scores on the Gray Oral Reading Paragraphs were secured for eighty subjects selected from the second to the sixth grade, inclusive. The scores for the individual subjects which were used in this part of the investigation have been given in Table II.

The relationship between growth in span of recognition and increase in oral reading ability is shown by the data in Table IX and by the corresponding curve in Figure 7. This figure should be read in the

same manner as those preceding, except that on the horizontal axis the modified score interval on the Gray reading test is given instead of school grade. The figure shows that those pupils who make modified scores on the Gray test of from 20 to 29 have a median of 12.8 fixations per line; that those pupils who fall in the score interval of from 30 to 39 have a median of 11.3 fixations per line, etc. The curve shows a rapid rise up to the Gray score interval of 50–59, following which the increase is more gradual. The scores on the Gray test are determined by freedom from such errors as mispronunciation, repetition, substitution,

TABLE IX

RELATIONSHIP BETWEEN AVERAGE NUMBER OF FIXATIONS PER LINE IN ORAL READING AND MODIFIED SCORE ON GRAY ORAL READING PARAGRAPHS

Average Number of Fixations per Line	Score Intervals on Gray Test						Total
	20–29	30–39	40–49	50–59	60–69	70–79	
5.0–5.9	.....	.....	.....	1	1	.....	2
6.0–6.9	.....	.....	.....	.....	1	.....	1
7.0–7.9	.....	1	2	1	2	.....	6
8.0–8.9	.....	2	5	8	5	1	21
9.0–9.9	.....	2	3	5	5	.....	15
10.0–10.9	1	2	7	2	1	.....	13
11.0–11.9	.....	4	1	2	1	.....	8
12.0–12.9	3	1	.....	1	.....	.....	5
13.0–13.9	.....	2	2	.....	.....	.....	4
14.0–14.9	.....	1	.....	.....	.....	.....	1
15.0–15.9	.....	1	.....	.....	.....	.....	1
16.0–16.9	2	.....	.....	.....	.....	.....	2
17.0–17.9	1	.....	.....	.....	.....	.....	1
Total	7	16	20	20	16	1	80
Median	12.8	11.3	10.0	9.0	8.8	8.5	.....

insertion, and omission of words. While the existence of a high correlation cannot be used to prove a causal relationship between the elements correlated, nevertheless the fact that the development of a wider recognition-span accompanies the elimination of these errors is suggestive. It is at least an additional item of evidence to indicate that a wide recognition-span is a fundamental element in reading and that up to a certain stage of maturity, growth in general achievement in oral reading is accompanied by a correspondingly rapid growth in span of recognition.

The relationship between growth in rate of recognition and score on the Gray test is shown in Table X and Figure 8. Here again the curve makes a rapid rise up to the interval 50–59 with a tendency to a less

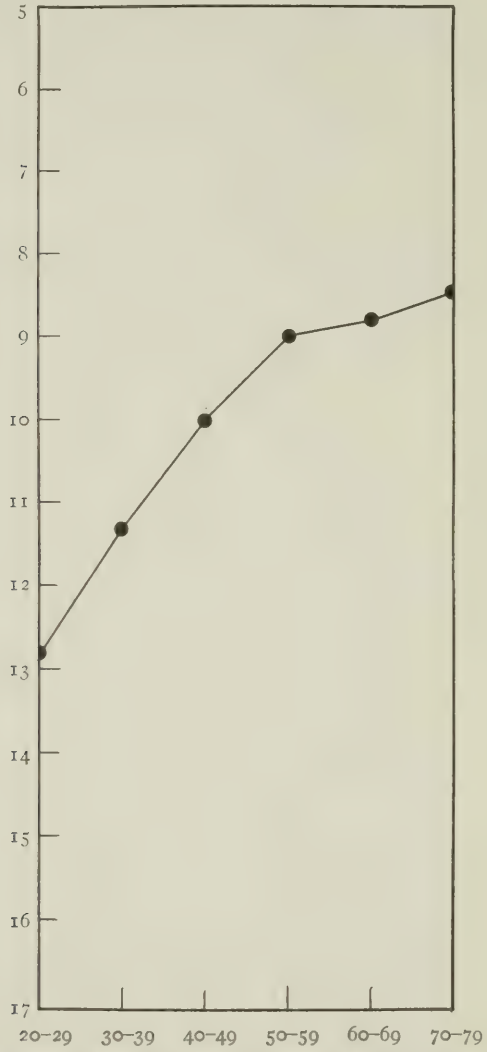


FIG. 7.—Relationship between average number of fixations per line in oral reading and modified score on Gray Oral Reading Paragraphs. Modified score on Gray oral test shown on horizontal axis; average number of fixations per line shown on vertical axis.

TABLE X

RELATIONSHIP BETWEEN AVERAGE DURATION OF FIXATION PAUSES IN ORAL READING AND MODIFIED SCORE ON GRAY ORAL READING PARAGRAPHS

Average Duration of Fixations	Score Interval on Gray Test						Total
	20–29	30–39	40–49	50–59	60–69	70–79	
6.0–6.9	.....	.....	3	7	6	1	17
7.0–7.9	.....	2	8	9	9	.....	28
8.0–8.9	.....	4	3	3	1	.....	11
9.0–9.9	2	5	2	1	.....	.....	10
10.0–10.9	2	3	4	.....	.....	.....	9
11.0–11.9	.....	1	.....	.....	.....	.....	1
12.0–12.9	2	1	.....	.....	.....	.....	3
13.0–13.9	.....	.....	.....	.....	.....	.....	.....
14.0–14.9	1	.....	.....	.....	.....	.....	1
Total	7	16	20	20	16	1	80
Median	10.8	9.4	7.9	7.3	7.2	6.5	.....

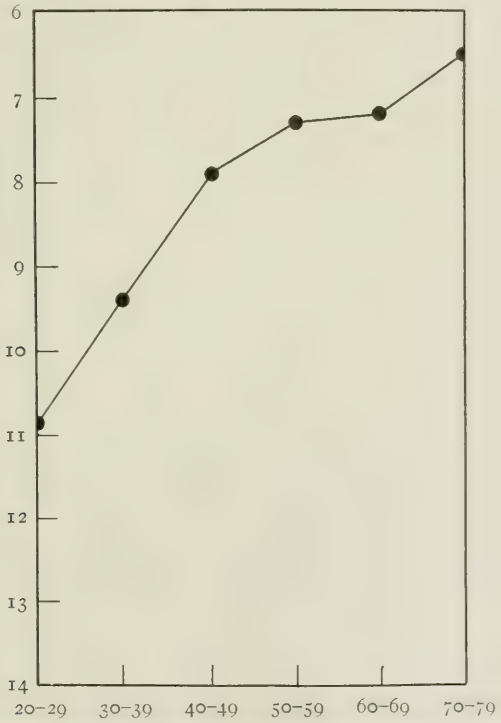


FIG. 8.—Relationship between average duration of fixation pauses in oral reading and modified score on Gray Oral Reading Paragraphs. Modified score on Gray oral test shown on horizontal axis; average duration of fixations shown on vertical axis.

pronounced increase beyond that point. The increase at the interval 70–79 represents only a single case and should not be emphasized unduly. The curve shows clearly that a development in the habit of quick recognition is a part of general improvement in reading ability.

Table XI and Figure 9 exhibit the data relative to the correlation between average number of regressive movements per line and modified score on the Gray Oral Reading Paragraphs. The growth curve shows a progressive, but not rapid, development in this habit of regularity of eye-fixations. There is no doubt that the reduction of the number of regressive movements is a difficult process, but the value of the development

TABLE XI

RELATIONSHIP BETWEEN AVERAGE NUMBER OF REGRESSIVE MOVEMENTS PER LINE IN ORAL READING AND MODIFIED SCORE ON GRAY ORAL READING PARAGRAPHS

Average Number of Regressive Movements per Line	Score Interval on Gray Test						Total
	20–29	30–39	40–49	50–59	60–69	70–79	
0.0–0.4	.....	.....	1	1	.....	.....	2
0.5–0.9	.....	1	.....	2	3	.....	6
1.0–1.4	.....	4	7	6	8	1	26
1.5–1.9	.....	3	5	7	1	.....	16
2.0–2.4	1	3	5	3	2	.....	14
2.5–2.9	3	1	1	.....	1	.....	6
3.0–3.4	.....	2	1	1	1	.....	5
3.5–3.9	.....	.....	.....	.....	.....	.....	.....
4.0–4.4	1	1	.....	.....	.....	.....	2
4.5–4.9	1	1	.....	.....	.....	.....	2
5.0–5.4	1	.....	.....	.....	.....	.....	1
Total	7	16	20	20	16	1	80
Median	2.9	2.0	1.7	1.6	1.3	1.2	.....

of regular, rhythmic eye-movements cannot be judged by the absolute size of the reduction. The subject who reduces the average number of regressive movements per line from 2 to 1 has accomplished a task which requires, on the average, three years of school training in reading. The ability to reduce the average number of regressive movements per line to 0.5 or less, as is done by a great many high-school and college students for silent reading, represents a degree of mastery which is characteristic of only those readers with the most mature reading-habits.

To summarize the three sets of data comparing growth in eye-movement habits with scores on the Gray test, it is clear that the curves of development for these three fundamental elements of reading show

similar rates of growth when based upon an objective measure of reading achievement and when based upon school grade. It must be remembered that all of the eighty subjects used for these three growth curves

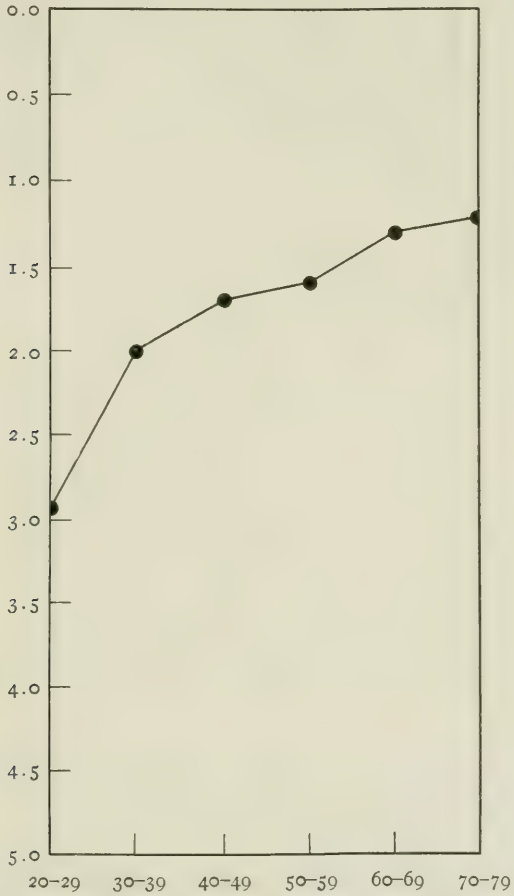


FIG. 9.—Relationship between average number of regressive movements per line in oral reading and modified scores on Gray Oral Reading Paragraphs. Modified scores on Gray oral test shown on horizontal axis; average number of regressive movements per line shown on vertical axis.

were selected from Grades II to VI, and consequently comparisons must be made with similar grades in the curves of Figures 4, 5, and 6. As the reader develops in span of recognition, rate of recognition, and regularity of procedure along the printed lines, he also becomes more

mature in the elements which are measured by the oral test, such as repetitions, omissions, substitutions, insertions, and mispronunciations.

EYE-MOVEMENT ELEMENTS AND COMPREHENSION IN SILENT READING

One turns with interest to the silent-reading process to see whether similar conditions are found. In order to secure data upon this problem, a group of sixty-four subjects who had taken the Monroe Silent Reading Test was selected from Grades III to VI, inclusive. The comprehension scores for these subjects, together with their eye-movement average, were shown in Table I.

TABLE XII

RELATIONSHIP BETWEEN AVERAGE NUMBER OF FIXATIONS PER LINE IN SILENT READING AND COMPREHENSION SCORE ON MONROE SILENT READING TEST

Average Number of Fixations per Line	Score Interval on Monroe Test					Total
	7–14	15–22	23–30	31–38	39–46	
5.0–5.9	.....	.....	.....	2	2	4
6.0–6.9	.....	2	12	2	3	19
7.0–7.9	1	3	4	3	4	15
8.0–8.9	2	3	5	3	.....	13
9.0–9.9	4	1	1	.....	.....	6
10.0–10.9	1	3	.....	.....	.....	4
11.0–11.9	1	.....	1	.....	.....	2
12.0–12.9	.....	1	.....	.....	.....	1
Total	9	13	23	10	9	64
Median	9.4	8.5	7.0	7.3	6.8	.....

The relationship between average number of fixations per line and comprehension score on the Monroe test is exhibited by Table XII and Figure 10. On the base line of Figure 10, score intervals on the Monroe test are substituted for school grade or score on the Gray test. The figure should, therefore, be read as follows: nine pupils made scores on the Monroe test ranging from 7 to 14, the median of their average number of fixations per line being 9.4; thirteen pupils fell in the score interval of 15 to 22, their median number of fixations being 8.5, etc. The curve, although irregular, shows an increase in the width of the recognition-span accompanying an increase in comprehension score. The greatest increase in span of recognition appears between the comprehension scores of 7 and 30. Beyond a score of 30, increase in recognition-span is not a large factor, or, to put it otherwise, a recognition unit wide

enough to accompany a comprehension level of 30 is almost equally well adapted to a comprehension score of 45.

Table XIII and Figure 11 show the relationship between average duration of fixations and comprehension score on the Monroe test. The curve in Figure 11 is negatively accelerated and closely resembles the

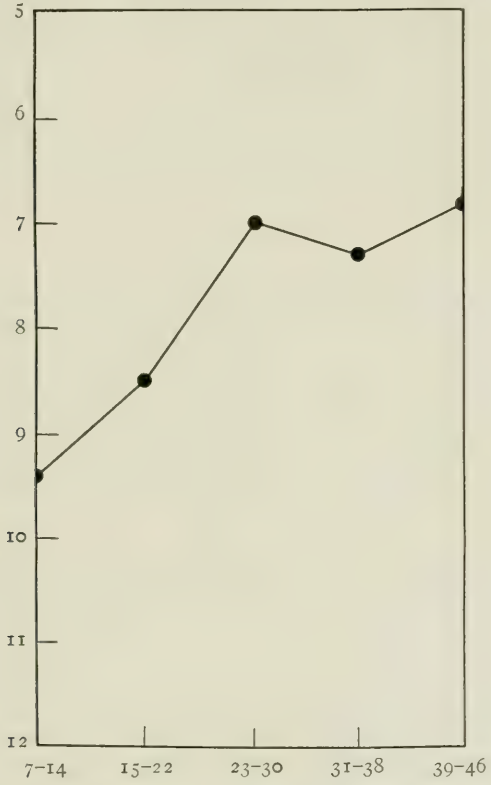


FIG. 10.—Relationship between average number of fixations per line in silent reading and comprehension score on Monroe Silent Reading Test. Score on Monroe test shown on horizontal axis; average number of fixations per line shown on vertical axis.

shape of the curve for this same element of Grades III to VI as shown in Figure 2. As ability to comprehend increases, the average recognition time becomes shorter. This means that when the recognition process becomes more nearly automatic and requires no special analytical effort the mental processes of the reader are relieved of the necessity of close attention to the perceptual elements and can therefore concentrate upon

the meaning of the passage with a resulting increase in the comprehension score.

Long fixations are symptoms of difficulty on the part of the reader. They occur chiefly in two kinds of situations. The first of these is when a particularly difficult word appears in the selection. At such points an excessive number of very long fixations generally appears. The mental process of the reader is engaged in an effort to analyze the word, during which the eye increases the duration of its fixations in order to give time for the reader to arrive at a final solution of the difficulty. A second type of situation in which very long fixations are found is on the occasion of a decided strain upon the mental process of interpretation. When the reader is in the attitude of intensive study

TABLE XIII

Relationship between Average Duration of Fixation Pauses in Silent Reading and Comprehension Score on Monroe Silent Reading Test

Average Duration of Fixations	Score Interval on Monroe Test					Total
	7–14	15–22	23–30	31–38	39–46	
5.0–5.9	.....	1	7	5	5	18
6.0–6.9	.....	7	12	4	3	26
7.0–7.9	3	2	4	1	1	11
8.0–8.9	3	2	.....	.....	.....	5
9.0–9.9	3	1	.....	.....	.....	4
Total	0	13	23	10	9	64
Median	8.5	6.8	6.4	6.0	5.9	.....

there is a distinct tendency to increase the length of fixations. When a point is reached where a phrase is highly charged with meaning, the reader frequently holds his eye in a fixed position while he makes the required mental interpretation. There are, however, individual variations in meeting this type of situation, since some readers let their eye wander in an apparently aimless series of short fixations while they make the necessary thought adjustment. A capital example of the nature of a long fixation pause may be drawn from a process different from reading. If a pupil is given a vertical column of digits with instructions to find the sum, the character of his eye-movements will be quite different from those in his ordinary reading process. The most conspicuous difference is in the duration of the fixations. While in the ordinary process of reading the average duration of a fixation pause for a fifth-grade pupil

is about 6 twenty-fifths of a second, in arithmetic addition the average pause ranges from 40 to 60 twenty-fifths with occasional fixations as long as 150 twenty-fifths of a second. It is not difficult to see the reason

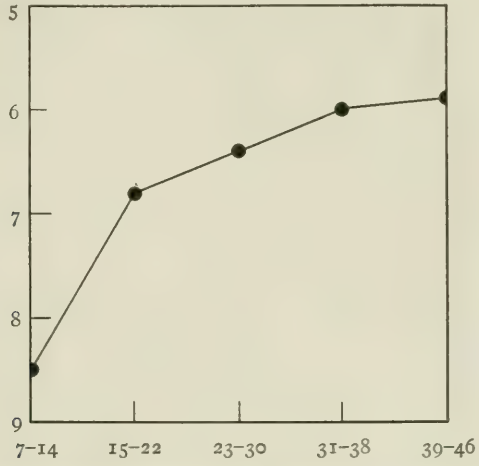


FIG. 11.—Relationship between average duration of fixation pauses in silent reading and comprehension score on the Monroe Silent Reading Test. Score on Monroe test shown on horizontal axis; average duration of fixation pauses shown on vertical axis.

TABLE XIV

RELATIONSHIP BETWEEN AVERAGE NUMBER OF REGRESSIVE MOVEMENTS PER LINE IN SILENT READING AND COMPREHENSION SCORE ON MONROE SILENT READING TEST

Average Number of Regressive Movements per Line	Score Interval on Monroe Test					Total
	7–14	15–22	23–30	31–38	39–46	
0.0–0.4	.....	.....	2	1	.....	3
0.5–0.9	.....	3	5	1	4	13
1.0–1.4	2	3	6	3	2	16
1.5–1.9	3	1	3	3	3	13
2.0–2.4	1	2	5	2	.....	10
2.5–2.9	1	2	.....	.....	.....	3
3.0–3.4	1	2	2	.....	.....	5
3.5–3.9	1	.....	.....	.....	.....	1
Total	9	13	23	10	9	64
Median	1.9	1.7	1.4	1.5	1.1	.....

for such long fixations in arithmetic addition. The perceptual problem of recognizing the digits makes a very minor demand. All that is required is that the pupil recognize the successive digits one at a time.

The difficult part of arithmetic addition consists of making the mental associations required for arriving at the correct answer. The child encounters a combination of 37 plus 9, and, since further perception will not aid him in making the association, he simply lets his eye rest

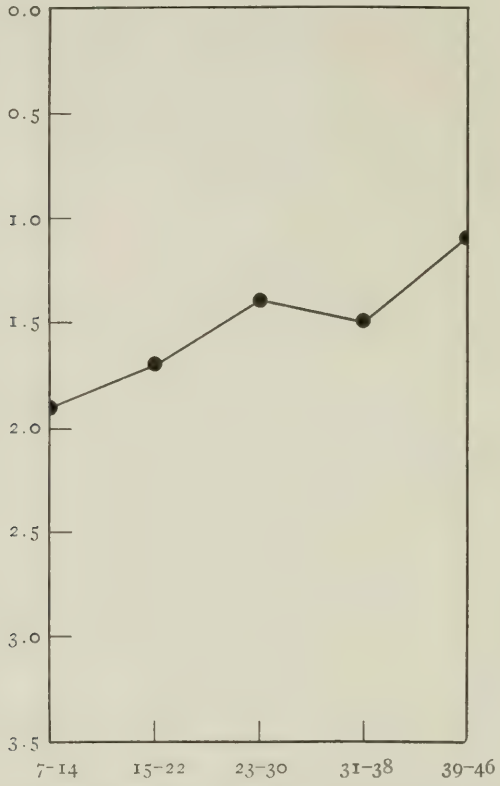


FIG. 12.—Relationship between average number of regressive movements per line in silent reading and comprehension score on Monroe Silent Reading Test. Score on Monroe test shown on horizontal axis; average number of regressive movements per line shown on vertical axis.

upon the same point while he is engaged in the mental labor of making the proper association. If it requires as long as 150 twenty-fifths of a second to arrive at the proper answer there is probably less distraction from a single long fixation than from a series of short ones which would introduce new material to the eye. Although further experimentation would be necessary to establish it, the writer proposes the hypothesis

that in general the presence of fixations which are very much longer than the subject's average fixation time is caused by central thought difficulties, while the presence in a given position of an excessive number of fixations indicates a confusion which is primarily related to the process of perception rather than interpretation. This hypothesis applies, however, to variations within a single record or for a single subject, and should not be interpreted to mean that a longer average fixation time indicates a greater degree of interpretation. In fact, the data presented in Figure 11 make it clear that in general a decrease in the average duration time accompanies an increase in comprehension. The mature reader who has less trouble with interpretation has fewer long fixation pauses and consequently a lower average fixation time.

The correlation between average number of regressive movements per line and comprehensive score on the Monroe test is shown in Table XIV and Figure 12. The curve in Figure 12 shows an increase in regularity of comprehension accompanying progress in ability to comprehend. The break in the direction of the curve indicates that while a certain level of regularity of eye-movements is sufficient for a considerable range of comprehension, the pupils who reached the highest level of comprehension had made a decided improvement in the rhythmic character of their eye-movements.

COMPARISON OF GROWTH CURVES FOR THREE ELEMENTS OF SILENT READING

Four groups of data have now been presented relating to the three fundamental characteristics of eye-movements habits, namely, the

TABLE XV

PERCENTAGE OF INCREASE IN GROWTH CURVES OF THREE EYE-MOVEMENT HABITS—SILENT READING

EYE-MOVEMENT HABIT	SCHOOL GRADE												
	I B	I A	II	III	IV	V	VI	VII	F	So	J	Se	Col
Average number fixations per line	0	17	42	52	60	63	60	63	61	69	70	66	68
Average duration of fixation.....	0	35	45	52	59	62	65	64	63	63	66	63	62
Average number regressive movements.....	0	22	55	65	73	75	71	71	80	86	86	86	90

average number of fixations per line, the average duration of the fixation pauses, and the average number of regressive movements. It has been shown that a decrease in the measure of each of these three characteristics accompanies (1) progress through school grades, (2) development of oral-reading ability, and (3) increase in comprehension in silent reading. The significance of these facts can be seen more clearly if the

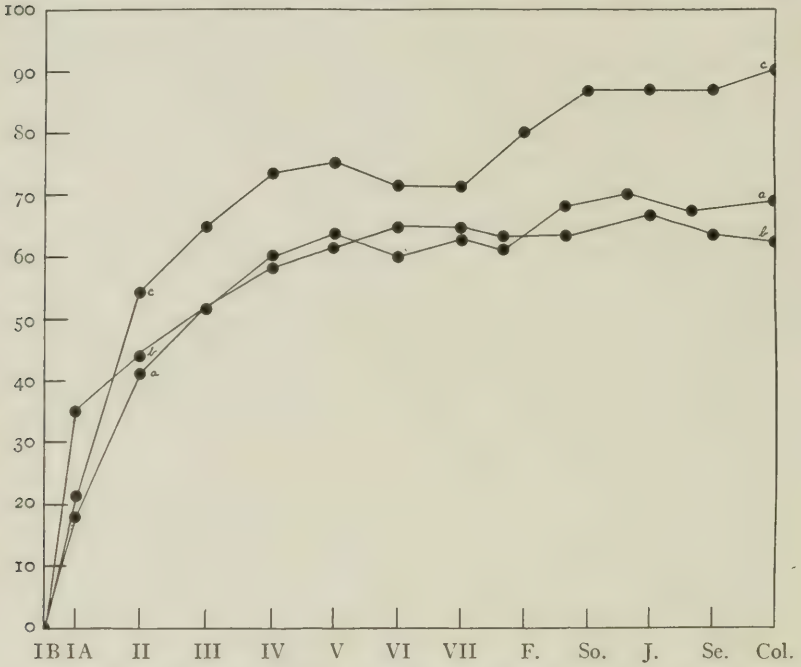


FIG. 13.—Per cent of increase in growth for three eye-movement habits—silent reading. School grade shown on horizontal axis; per cent of increase shown on vertical axis. Curve *a* represents average number of fixations per line; curve *b* average duration of fixation pauses; curve *c* average number of regressive movements per line.

curves of growth for the different elements studied are plotted on the same graph where their characteristics can be compared.

In order to reduce the curves for the three measures of eye-movements to a similar scale, the percentage of increase at the different grade levels was computed, the median for Grade I B being taken as the base. The percentage of increase in the successive grades is shown in Table XV. This table should be read as follows: in respect to growth in average number of fixations per line the median for Grade I A showed

an increase over Grade I B of 17 per cent; the median for Grade II an increase of 42 per cent; the median for Grade III an increase of 52 per cent, etc. In the same manner the percentage of increase in growth for average duration of fixations and for average number of regressive movements per line is given. These data are expressed in graphic form in Figure 13.

The presentation of the three curves upon the same background serves to emphasize the fact that the period of major development of the elements of span of recognition, speed of recognition, and regularity of eye-movements across the line comes during the first four grades. A continued rise in the growth curves is apparent in the fifth grade, but it is relatively small in amount. The turning-point in the direction of the curves appears at the end of the fourth grade. Other investigations in reading have also shown that the fourth grade is a crucial point. The indications are that the character of the reading process is different during the first four years than in the later period. Certainly in the fifth, sixth, and seventh grades the type of development is entirely different than in the first four years. Evidently these stages of development are sufficiently clear to suggest a definite variation in the treatment of the school.

The later rise in the curves for regressive movements and average number of fixations per line suggests that the high school is concerned with a reading problem quite definite in character. It would be an interesting experiment to determine whether a modification of the reading course in the intermediate grades would eliminate the plateau in these two curves. If this could be accomplished one would expect a considerable improvement in the character of the reading during this period.

In this chapter the facts presented have emphasized the growth of the normal or average pupils. This has been accomplished by combining the data for a large number of subjects. Mass data show general trends, but they also cover up many significant individual variations. In the following chapter the method of study will change from the statistical treatment of many cases to an analytical treatment of the detailed characteristics of certain groups of individuals.

CHAPTER III

DETAILED ANALYSIS OF FIRST-GRADE READING

The reading work of the first grade is without doubt more important than that of any other single year of the elementary school. It is at the beginning of reading that the pupils get their fundamental attitude toward the reading process. It is here that the first basic habits are formed. A wrong start in the first grade is particularly unfortunate since it necessitates the later undoing of foundational habits and attitudes. A study of the pupil's reading at this level, therefore, is sure to uncover some very significant facts.

Through a comparison of the reading records of immature and mature readers, such as was made in Plates I and II, it is possible to define the approximate initial point and the ultimate goal of reading. As has been pointed out in chapter i, the determination of the ultimate goal in reading does not indicate the nature of the growth stages through which a particular pupil passes in reaching the state of maturity. In order to throw more light upon the detailed steps of this growth process, the data in chapter ii were presented. The normal growth curves for three elements of reading were shown, from which the median position in each grade was apparent. However, each grade median was based upon a different group of subjects, so what the curves really show is not the continuous progress of any particular subject but, rather, a series of cross-sections which gives a true picture of growth only when applied to the large group. If any of the tables accompanying the growth curves are examined again it will be noted that many subjects deviated more or less from these normal curves. Therefore, the interpretation of the growth curves must be that they show the normal progress for the group as a whole—the most common route toward the ultimate goal of maturity. Individuals may deviate somewhat from this normal route and follow a quite different line of progress. But the fact to be emphasized with all the individuals is that sooner or later they must reach the goal. Their route may be devious or direct, but the ultimate goal, if indeed they reach it, is the same for all.

The direction of the route over which the pupils travel depends largely upon the method of teaching. One school may begin its reading work by teaching children the alphabet, then simple words, and later

sentences. Children taught by this method will ultimately learn to read. Many adults can be found who did learn by this method. Their curve of progress toward maturity followed a definite route. It is not the same route, however, as that which will be traveled by the pupil who spends no time upon *a b c*'s but who begins with some other process of word-analysis. A still different curve of progress will be found where the initial emphasis is placed upon the sentence or some large thought unit. The nature of various methods of reaching a stage of maturity may be illustrated by the hypothetical curves in Figure 14.

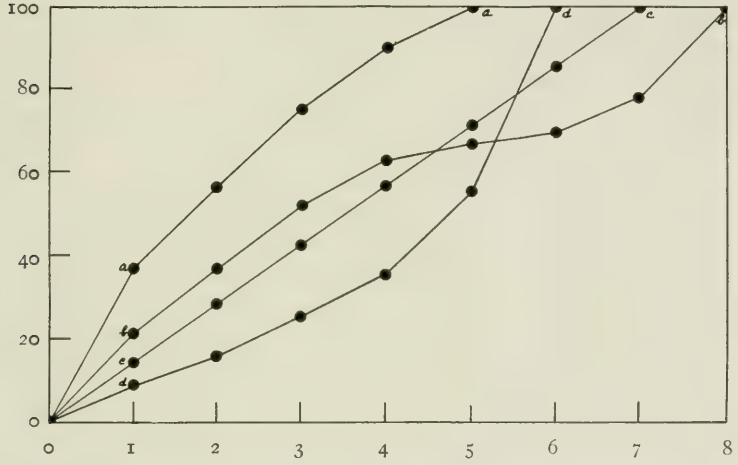


FIG. 14.—Diagram illustrating hypothetical progress toward maturity. Number of years of school experience shown on base line; per cent of maturity shown on vertical axis.

In this figure the vertical axis represents the percentage of maturity attained by readers where 100 per cent equals the average maturity to be expected in an eight-year elementary school. The base line represents the number of years of practice in reading. Curves *a*, *b*, *c*, and *d* represent progress according to four purely hypothetical methods of teaching reading. According to method *a* maturity will be reached in five years, according to method *b* in eight years, with method *c* in seven years, and with method *d* in six years. With method *a* the pupils make rapid progress at the beginning and maintain a fairly high rate until maturity is reached. With method *b* progress during the first four years is rapid, during the next three rather slow, but during the eighth year it is again rapid. Method *c* produces a perfectly con-

stant rate of progress, with the same amount of gain each year. Method *d* begins very slowly but succeeds later in stimulating a very rapid growth. If now these four methods are judged at the end of two years of school work they would be ranked in order of merit *a*, *b*, *c*, *d*. However, if their merit is judged by the manner in which they ultimately reach a stage of maturity, the ranking will be *a*, *d*, *c*, *b*. The illustration shows the danger of attempting to evaluate a method until its total growth curve is known.

The form of a total growth curve depends upon the order and rate of development of the various elements which enter into its composition. The theoretically most direct route toward maturity, which would produce the symmetrical development of all the elements involved, might be very different from the most economical and practical route. The theoretically direct route in the construction of a skyscraper would be to complete each story before adding the next; but the economical route is to complete all of the steel structure before the building is inclosed, to put in all the plumbing before the walls are finished, etc. A skyscraper may be very mature from the standpoint of its steel structure, but be very immature in its interior finish. In like manner one method of teaching reading may produce in the third grade a high degree of maturity in word-analysis and pronunciation, together with very immature habits of interpretation.

Considering these facts, it will be the purpose of the present chapter to describe certain methods of teaching in the first grade, and then, by a detailed analysis, to show the effects of the different methods upon the fundamental elements of reading. It is not the function of the psychologist to evaluate methods, but rather to furnish a scientific analysis of the relationship between methods and results. This analysis must go into sufficient detail to show the type of growth in the various elements of reading when different methods are used, in order that the teachers and supervisors of reading may make their evaluation upon a scientific basis.

A further purpose of this chapter is to show how, from the very beginning of reading, pupils take different courses in the various elements of the process. Many of these variations are of the nature of short by-paths leading sooner or later back into the normal route toward maturity. In some cases, however, the deviations from normal progress continue and eventually cause the types of decided variation which will be described in the next chapter. The nature of such deviations can be best understood when they are seen as the continuation of individual variations which have their origin in the earliest stages of reading.

Up to the time of the present investigation, as far as the writer has been able to ascertain, no study of the reading of first-grade pupils has been made by the photographic method. The general immaturity of pupils at this level would seem to prohibit them from serving as subjects for such an experiment. In making a trial, however, it was found that first-grade children behaved as normally before the camera as their older schoolmates, and that their eye-movement records are valid. Practically the only difference which was noticed was the somewhat greater amount of head-movement. In only a few cases did this prove so serious that the films had to be discarded. By exercising all possible speed and dexterity in operating the camera, it was possible to secure records of the two paragraphs in an average of five minutes for each subject. This allowed little time for nervousness or for fatigue from sitting in the same position before the camera.

For the purpose of securing records at different stages of progress during the first year, photographs of a group of pupils from Grade I B were taken during the seventh week of the school year, again during the thirteenth week, and again during the seventeenth week. Records were also secured from a group of I A children at the same time. Since they had already attended school one semester, their records were taken after a school experience of twenty-five, thirty-one, and thirty-five weeks. This method gave records at six intervals during the first school year.

As subjects for these first-grade experiments twelve children were selected from Grade I B and nine from Grade I A of the University laboratory school. In addition to these, four I B and six I A children were secured from a neighboring public school, this group being used, however, only at the end of the semester. This made a total group of thirty-one first-grade pupils. It was a part of the original plan to secure three records from each of the subjects from the University Elementary School. Sickness and other causes interfered in some cases, so that the complete series of three records was obtained from only nine of the pupils. No subject from the University first grade missed more than one test, however, so as a result sixty-one photographic records were available for the total group of thirty-one subjects. Dictaphone records were secured of the oral readings at the same time the photographs were made. The basis upon which the subjects were selected was that both the exceptionally good and the exceptionally poor readers were to be excluded, the pupils being taken from the middle group. The purpose of this method was to secure typical first-grade pupils.

PLATE V

The little red hen found a seed.
It was a wheat seed.
The little red hen said,
"Who will plant the seed?"
The pig said, "Not I."
The dog said, "Not I."
The little red hen said, "I will."

A boy had a dog.
The dog ran into the woods.
The boy ran after the dog.
He wanted the dog to go home.
But the dog would not go home.
The little boy said,
"I cannot go home without my dog."
Then the boy began to cry.

Selections used for initial test of first-grade subjects

The selections used for the first test are shown in Plate V. Those used in the later tests have already been exhibited in Plate III. The "Little Red Hen" story, in the form used in the first test, had been read by all of the I B subjects from the University group in their regular school work, most of them having memorized it when it was read in class.

CONTRASTS IN METHODS OF TEACHING

Before presenting the results of the experiments it will be well to notice the methods of teaching which were employed in the two schools from which the children were selected. This will furnish a background for the interpretation of the analytical studies of individual cases.

The children from the public school had learned to read by a method which placed the major emphasis upon word mastery. Elaborate phonic drill was provided in a separate period. Sufficient drill was given to secure great independence in the recognition of words. In teaching a new selection the teacher first told the story *in her own words* in order to stimulate an attitude of interest on the part of the pupils. Next she wrote the new words upon the board, drilling the children upon them as she proceeded. If a word possessed any particular difficulty she broke it up into its phonic elements and assisted the pupils in attacking it by their regular method of word-analysis. After all the new words had been studied the pupils read the selection orally. Following the oral reading they were drilled in finding certain sentences or lines upon being given such directions as, "Find the line which begins with a girl's name" or "Find the sentence which begins with 'they.'" While the teacher frequently directed the pupils' attention to a better form of expression, it was clear that the principal element in the method was that of word-recognition, interpretation receiving secondary consideration.

The children in the University school were instructed by a radically different method. In the beginning stages great emphasis was placed upon securing the correct reading attitude of trying to get meaningful experiences from the printed material and of creating a desire to read by providing interesting content. The method proceeded from the whole story to lines and phrases, and finally to individual word study. The word study was not given major consideration but was subordinated to the development of a proper reading attitude. In detail, the early work of the grade was carried out as follows: first, the teacher told the story *in the exact words of the book;* second, she re-told it, displaying in the meantime certain phrases or words which were prominent in the story; third, the pupils told the teacher how to write the story on the

board; fourth, the pupils read the story; and fifth, they were drilled upon the individual lines, phrases, and words. The general principle of the method is to get the entire thought of the story first, and later subdivide it for reading practice. By this method, it will be observed, the pupils will learn to recognize words or phrases in the setting of the story before the same words will be recognized when standing alone or when appearing in a new paragraph.

The essential points of contrast between the two methods are as follows. The public school emphasized word-analysis and recognition above everything else, giving a very large amount of drill in this element. It attempted to stimulate an attitude of interest toward the selection to be read, but not by telling it in the words of the text. The University school placed the chief emphasis upon securing a correct reading attitude by which the child would look for the large meanings in the selection. It did this by letting the child memorize the story before reading it. This was followed by phrase and word drill, but with much less attention to words than in the public school. The University school also gave more opportunity for silent study of the story to be read. In summary, the public-school method emphasized mastery of mechanics; the University school emphasized the process of fusing the words and phrases into meaningful units.

With the foregoing description of methods as a background, the detailed data of the experiments with the first-grade children will be focused upon four problems of reading, namely, (1) the development of a proper reading attitude; (2) the growth of the fundamental elements of span of recognition, speed of recognition, and regular procedure along the printed lines; (3) the problem of word-recognition; and (4) the development of a rhythmic expression or interpretation in thought units as contrasted with the mechanical pronunciation of words.

DEVELOPMENT OF A CORRECT READING ATTITUDE

One of the first problems in teaching reading is the production of a correct attitude toward printed material. The goal of maturity in this respect is an attitude which considers reading as a process of getting ideas about something, the words of the printed page giving those ideas. For the mature subject reading consists of the fusing of words into thought units, with the attention primarily focused upon the interpretation of the meaning. The process of reading, therefore, is more than the successive pronunciation of words, which may or may not be accompanied by the mental fusion of the words into thought units.

As soon as the child enters school he is forced to take some attitude toward reading. The attitude he takes may resemble or differ from that which is characteristic of maturity, but regardless of this the pupil looks at the process of reading in one way or another. Methods of teaching are of course interested in developing a proper attitude, but the concepts of just what is the proper attitude at this initial stage differ. The one fact which can be emphasized is that regardless of what attitude the pupil may assume at first, he must ultimately develop the attitude which is characteristic of maturity—reading by thought rather than by word units.

Recognizing the outcomes of developing habits of reading by words rather than by thoughts, methods of teaching reading have recently been emphasizing the use of the sentence rather than the word as the unit. While the aim of this plan is to develop a mature attitude toward reading, certain difficulties are encountered in practice. In the anxiety to have the pupils get meaning in sentence units one is apt to forget that the mental process by which one does this *after* he has learned to read is quite different from the mental process involved *during* the period of learning. The beginning pupil's perceptual units are small and unorganized. Seeing a sentence is one thing for the mature reader and quite another for the beginner. The result often is that in a pupil's haste to see the sentence as a whole he overlooks the elements of which it is constituted. He gets blurred and inaccurate meanings.

One of the methods of attempting to produce this sentence-reading attitude is for the teacher first to tell the story in verbatim form, after which the pupils read it. In many cases the pupils get from this method, not an attitude of regarding a sentence as the expression of a single thought, but rather a habit of first learning the sentence or story from hearing the teacher tell it, and then reciting it from memory while their eyes roam at random over the page. They do not develop habits of following the words in their regular order. They get a bird's-eye view of the printed lines and fail to learn that a fused meaning of a sentence can only be secured from noting the particular combination of the words.

In order to furnish concrete examples of the various reading attitudes taken by beginning pupils, an analysis will be made of a number of individual cases.

The first photographic records of the subjects from Grade I B were taken during the seventh week of school. It was the purpose of the writer to secure records showing the earliest type of eye-movements. It

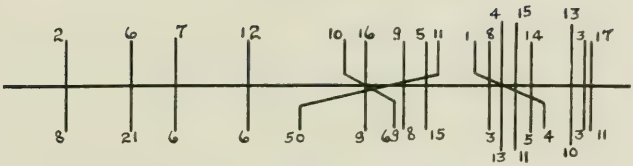
was not expected that these children would do very much reading at this stage. The principal interest lay in seeing how their attitudes and their habits were related. Up to this point the chief aim of the classroom had been to develop the attitude that reading was a process of getting whole units of thought from printed words.

The eye-movement records show that in this first test there were only five of the I B pupils who followed the words in their reading, proceeding regularly from line to line. The other five noted at the beginning that the selection was the familiar "Little Red Hen" story and thereupon repeated it from memory, letting their eyes move over the page without regard to the printed words. It is of interest to note that they did this for both oral and silent reading. They had not yet reached the stage of maturity where regular eye-movements give evidence that the reader is getting meaning from the printed page rather than from memory. The fact that five pupils made no attempt to follow the lines indicates that the reading attitude which this method aims ultimately to secure had not been approached during the first seven weeks of school.

The oral-reading record of Subject 188, a pupil in Grade I A appears in Plate VI. This subject made only 17 eye-movements in "reading" the entire seven lines of the "Little Red Hen" story. These fixations are plotted accurately in regard to their horizontal distribution, but since the eye did not follow the lines it was impossible to determine accurately the vertical location of the fixations. They are plotted, therefore, on a single horizontal line, but were in reality distributed vertically at various points up and down the page. The fact of interest in this record is that the pupil repeated the entire selection without attempting to follow the lines, taking the attitude of reciting from memory rather than that of ascertaining the meaning from the printed page.

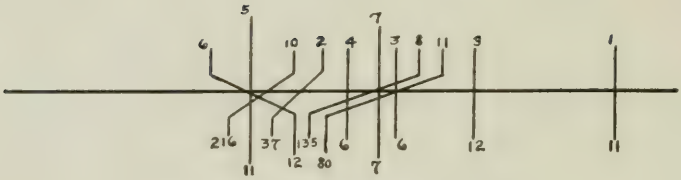
Plate VII gives the silent-reading record of Subject 187. The pupil was directed to re-read the same selection of seven lines silently, and to tell the experimenter as soon as he had finished. He carried out the direction in a serious manner, informing the experimenter when he had completed the reading. His eye-movement record reveals quite clearly what had been going on in his mind. He had made 11 fixations for the entire seven lines. These, again, are shown on a single horizontal distribution since it was impossible to determine with precision the vertical location of the fixations. Evidently the silent-reading process for this pupil meant a silent repetition of the selection, merely looking at the page in the meantime. The fact that some of his fixations were

PLATE VI



Oral reading by Subject 188, Grade I B

PLATE VII



Silent reading by Subject 187, Grade I B

extremely long is indicative of his mental processes. These long fixations occur when the subject is concerned with some inner thought process rather than with the perceptual stimuli. They indicate that he was spending his energy in trying to repeat from memory rather than in examining the words before him. These long, slowly shifting eye-fixations are of the same type as those which occur in arithmetic addition when a difficult combination is encountered, and where the mental process is concerned not with the perception of the stimuli but rather with the internal thought activity needed for reaching the proper answer. In the case of Subject 187, his record indicates that he was getting his cues for whatever reading was going on, not from the printed page before him, but rather from his memory of the story which he had previously learned in class. Certainly this is not the reading attitude which the teacher aims ultimately to secure.

The record of one more subject, Number 189, will be presented for purposes of further illustration. In his first test, November 11, 1921, this subject recognized that the material was the "Little Red Hen" story, and he accordingly made a stumbling attempt to repeat it. He did not remember the story verbatim and had considerable difficulty. His eye-movements covered the page apparently at random. In silent reading of the same selection he evidently repeated the process. His eye record, plotted on a single horizontal line, is shown in Plate VIII. He made a total of 13 fixations, several of them being long in duration.

A second record was taken of this subject on January ninth, using the modification of the "Little Red Hen" story which was shown in Plate III. In reading this selection orally he made a total of 35 fixation pauses, but his eyes still showed no consistent following of the lines. He apparently made an attempt to attach his memory of the story in its original form to the modified form before him, succeeding only partially. His dictaphone record, which should be compared with the selection in Plate III, read as follows:

One ----- one day ---------- found a seed. It was a wheat seed. She said, "Who will plant the seed?" The pig said, "Not I." The cat said, "Not I." The little red hen said, "I will then." And she did.

A third record was taken of this subject's reading on February first. At this time the same story was used as in the second test. His record showed that he was now following the printed lines while reading, although in a very irregular fashion. His dictaphone record indicated, however, that he was still attempting to get the meaning more from memory than from the printed story before him. He was unable to recognize

PLATE VIII

Silent reading by Subject 189, Grade I B

some of the simplest words. His reading, as recorded by the dictaphone, was as follows:

One day a – – a little red hen found a – – some seed. She – – she said to – – – – – the hen said, "Not I." [No – – no – – What is that next word there?] "No, I will plant this seed." She planted – – – to the pig. "Not I," said the pig. The little red hen said, "Who will plant the seed?" The pig said, "Not I." The cat said, "Not I."

At this point he seemed so hopelessly confused that he was told not to read further.

At the end of his first semester this boy was still in the most immature stage of reading. His records show that he was just beginning to follow the lines consistently; that his average fixation time for silent reading had been reduced from 27.9 twenty-fifths of a second at the first test to an average of 15.8 at the last test, that he was unable independently to attack some very simple words, and that he was unable to free himself from his early habit of depending upon his memory of the story rather than upon the printed words.

As further evidence of the effect of memorizing the stories, the following dictaphone records are given, showing the reading of the same paragraph by four pupils from Grade I B after sixteen weeks of school experience.

For convenience of comparison, the paragraph as it actually appeared is reproduced. It reads as follows:

One day a red hen found a little wheat seed. She said to the dog, "Will you plant my wheat seed?" The dog said, "No, I will not plant your little wheat seed." The hen said to the pig, "Will you plant my wheat seed?" The pig said, "Yes, I will plant your seed."

Subject 187 read it in this fashion:

One day a red hen found – – found a little wheat seed. She called – – [no] she called – – said – – [no] – she called – – said – – said – – to the pig, "Will you plant my little seed?" The dog said, "No, I will plant – – – I will – – will," said the little red hen. The – – – the hen said to the pig – – the dog, "Will you plant the seed?" The – – the hen – – the – – the – – the – – [no] the – – the pig said, "I won't." The – – the – –

Subject 191:

One day – – one day – – one day a little red hen found a wheat seed. She said, "Who will plant this wheat seed – – said who will plant this wheat seed." "Not I," said the cat. "Not I," said the pig. "Not I," said the dog. "Not I," said – – [no] – – "Not I," said – – – "Not I," said the duck. "Not – not I," said the – – "Not I," said the goose. "Not I," said the duck, "Then I will," said the little red hen. And she did.

Subject 192 showed such similarity in reading at her second and third periods of testing that both records will be given. On January ninth she read as follows:

One day there – – – a – – – a red hen found a seed. It – – – said – – – "This is a wheat seed." So she did – – she said – – "Who will plant the seed?" The dog said, "I won't." The pig said, "I won't." The little red hen said, "I will," and so she did.

On February second she read the same paragraph in this manner:

One day a red hen found a wheat seed. She said, "Who will plant the seed?" The dog said, "I won't." The pig said, "I won't." The cat said, "I won't." So the little red hen said, "I will."

Twelve pupils from Grade I B were used in this third series of tests. When five of the twelve give such readings as have just been presented, it is clear that a considerable period of time is required to establish the attitude of securing meaning from the printed page by the use of a method which first tells the story to the children in the exact words of the book. The tendency of the pupils is to depend upon their memory of the story rather than their perception of the printed lines. All of the pupils from the I B grade of the public school, where the method emphasized word-recognition but did not tell the story in the exact words, followed the lines and read the story as it was printed. However, most of them read it in a very mechanical fashion, without giving any evidence from their expression that they appreciated the meaning of the story. The University I B group displayed a lively interest in the content, even though they frequently varied from the printed text.

By means of these detailed case analyses the immediate outcomes of two contrasting methods have been shown. If the primary emphasis is placed upon word-recognition the outcome is the ability to follow the printed lines, to pronounce all the words, but to display no vital concern for the content. It produces what is familiarly called word reading. This is not the complete attitude of the mature reader. The method goes far in the development of word-recognition, an element which all pupils must ultimately develop. It leaves much to be done in securing an attitude of reading by thought wholes.

On the other hand, when the chief emphasis is placed upon the thought and the story is memorized the pupils do develop a vital concern for the content, but develop more slowly in word-recognition and in ability to follow the lines.

Neither method should be judged by the outcomes at the end of the first semester. The purpose of analysis is to indicate that the two

methods start out by different routes, one emphasizing words, the other emphasizing content. Ultimately the pupils must become mature in both. The important fact is that the teacher recognize that the adoption of either method means the carrying over of the undeveloped elements to a higher level in school. The selection of a method resolves itself into the question of which elements shall be developed first and what shall be the rate of development. Ultimately all the fundamental elements must be carried to maturity.

INITIATION OF PROPER EYE-MOVEMENT HABITS

Since the plans of the first-grade experiment provided for a series of records taken at three different stages of both Grade I B and Grade I A, it was thought that there would be available sufficient data to show growth curves at this level based upon medians for the three types of eye-movement habits. However, the wide variability in the records, together with the fact that some of the subjects were irregular, makes the construction of such growth curves undesirable. The number of cases at each point would be too small to give reliable medians. Some of the records will, therefore, be treated in a detailed analytical manner, with no attempt to give a quantitative statistical treatment to the whole series.

The particular problem of this section of the chapter is to discover the change in the character of eye-movement habits during the first school year. The development during the first six weeks has already been discussed in the preceding pages. It is clear that while some subjects develop eye-movement habits consistent with the reading process by the seventh week, others have not yet learned to follow the lines carefully. For those pupils who do follow the printed lines, there is evidence of much irregularity, the eyes frequently going beyond the end of the lines or swinging back too far at the beginning of a new line.

The comparison of the oral reading of the first test with that at the end of the thirteenth week of the semester is vitiated by the fact that even the I A pupils repeated the story very largely from memory, following the lines only in a cursory fashion. This fact is clearly shown by comparing the average number of fixations per line for the first and second readings by the pupils in Grade I A. It should be remembered that the selection used in the second test was simply a rearrangement of the first story in an unfamiliar form, most of the pupils knowing the first form from memory while the second was new to all.

Table XVI shows the average number of fixations per line for the eight subjects who took both tests. In every case except one there was an increase in the number of eye-movements per line in the second record. Since the growth curves in chapter ii have shown that the development of maturity in reading tends to reduce the number of fixations, these data would make it appear that the pupils were less mature in the thirteenth week of the second semester than in the seventh week. However, the true interpretation, when one considers the fact that the pupils had memorized the first selection, is that the second test more nearly represents their ability to get meaning from a printed page, whereas the first test clearly indicates that they were relying not so much upon their perception of the words of the story as upon their

TABLE XVI

AVERAGE NUMBER OF FIXATIONS PER LINE IN FIRST AND SECOND TESTS—FIRST-GRADE SUBJECTS

Subject	Average Number of Fixations per Line in First Test	Average Number of Fixations per Line in Second Test
10	19.0	29.4
11	8.0	13.3
12	13.0	16.8
13	16.0	24.0
14	12.7	12.2
182	19.0	24.2
193	14.0	18.8
194	8.0	9.4

memory of it. The wide variation in the average number of fixations per line in the second test is interesting. Subject 10 makes more than three times as many fixations per line as Subject 194, yet both are in the same reading class.

When the records of a single subject are followed for the three different tests, it is found that there is again much individual variation. Some make rapid progress in the development of eye-movement habits, while others show only small gains. Also it is of interest to note that for some subjects the gain is primarily in size of recognition-span; for others it is only in a reduction of the average fixation time; while for some there is improvement in both.

Subject 11, a pupil in Grade I A, shows a clear gain in regard to average fixation time for both oral and silent reading. Her average fixation time for the three consecutive tests is 22.2, 17.5, and 11.9 for oral reading, and 18.1, 13.4, and 10.8 for silent reading. This repre-

sents a consistent improvement of a considerable amount for one semester. Her records failed to show any marked improvement, however, in average number of fixations per line or in average number of regressive movements per line. The three eye-movement records of this subject are shown in Plates IX, X, and XI for the first, second, and third tests, respectively. In regard to number of fixations per line the record of the second test is better than that of the third test.

Subject 13, also in Grade I A, made consistent improvement in all three eye-movement habits. His silent reading records show that his averages were, in the three tests respectively, for the average number of fixations per line, 20.0, 17.0, and 13.5; for average duration of fixations, 22.0, 15.0, and 11.5; and for average number of regressive movements per line, 8.0, 4.5, and 4.0. The silent reading eye-movement record of his first test is shown in Plate XII, while sections of that of the second and third tests are shown in Plate XIII. The type of development which this subject exhibits shows rapid progress toward maturity in the elements measured by eye-movements.

Two records will be presented to illustrate the wide variations found in the first grade in oral reading. Plate XIV gives the eye-movements of Subject 194, one of the most mature first-grade pupils tested. This boy had learned to read at home and consequently found the reading work of the first grade very easy. This oral record was taken at the time of the second test. It shows an average of 9.4 fixations per line, an average of 9.7 twenty-fifths of a second per fixation, and an average of 0.8 regressive movements per line. The degree of maturity of this subject is at once apparent when these averages are compared with the grade medians exhibited by the tables in chapter ii.

As contrasted with this subject, the oral-reading record of a very immature reader is given in Plate XV. In the second test this subject made an average of 29.4 fixations per line, an average of 18.3 twenty-fifths of a second per fixation, and an average of 8.6 regressive movements per line. A large amount of prompting was necessary to enable him to read the story in any fashion at all. His utter confusion in several lines shows that he is entirely lacking in habits of dealing independently with new words. The word "said" caused confusion each time it was encountered. The word "yes" was unfamiliar, as were half a dozen other simple words in the paragraph. Records were secured from this subject at each of the test dates, and all were exceedingly immature in their characteristics. His reading was very erratic, even within the same selection. The most noticeable deficiency was his small visual

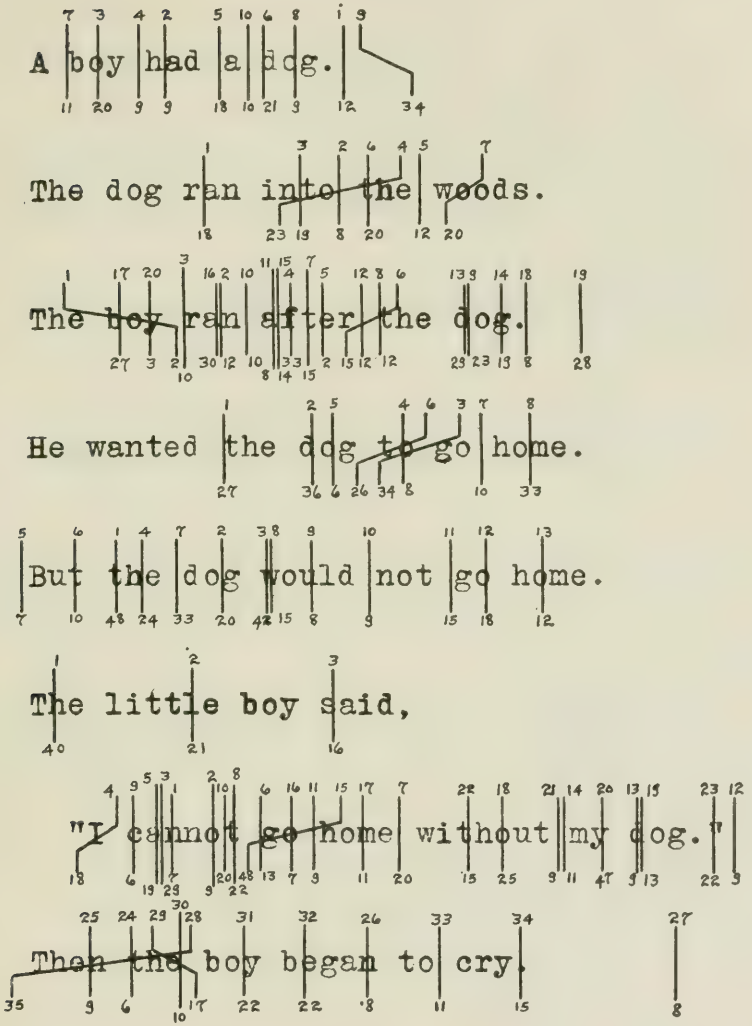
vocabulary, and his entire inability to cope with a new word. This subject is unable to begin to keep pace with Subject 194 and the other more mature readers in his class. It seems doubtful whether he is being helped by the regular class work. Certain it is that in at least four fundamental reading elements, namely, span of recognition, duration of fixations, regularity of eye-movements, and word-recognition, he is extremely immature. It would seem that here is an excellent example of a subject who needs specific rather than general teaching.

Two other subjects from the same grade may be used to illustrate the extent of difference in silent-reading ability. Subject 15, whose eye-movement record is shown in Plate XVI, ranks as a very mature reader for Grade I A. He made an average of 7.0 fixations per line, an average of 6.8 twenty-fifths of a second per fixation, and an average of 0.8 regressive movements per line.

As compared with the subjects just described, Subject 19, whose record appears in Plate XVII, has much less mature habits of reading. Her eye-movement averages for silent reading were 20.8 fixations per line, 10.3 twenty-fifths of a second per fixation, and 6.0 regressive movements per line. This subject is a little Chinese girl from the public-school group. A general characteristic of this, as of many of the public-school records, is that the subject moves along in a series of small units from one end of the line to the other. Although she makes an average of 6 regressive movements per line, nearly all are small. If the serial order of the eye-fixations is examined closely it will be seen that the reading process for this subject consists of creeping along very slowly from the beginning to the end of the line, with a frequent insertion of short backward movements. Such eye-movements indicate that the mental processes of the reader are chiefly concerned with a detailed analysis of words. Grasping the thought in large units is impossible with such a narrow recognition-span as this subject possesses.

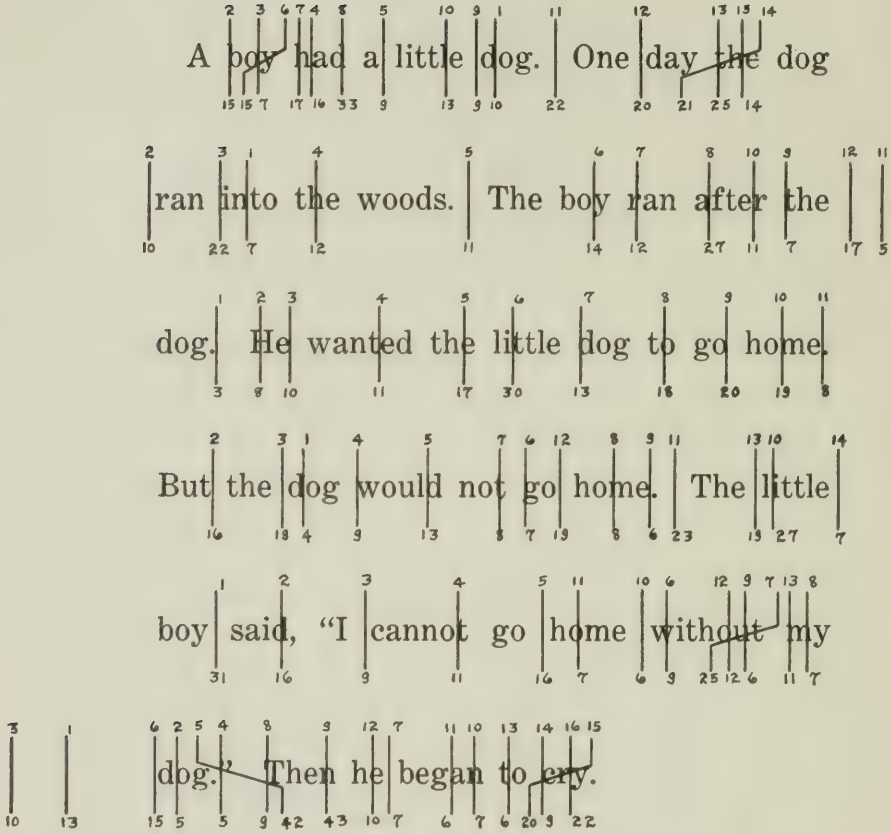
The type of reading exhibited by Subject 19 is the direct result of an overemphasis upon word-recognition. Reading for this subject consists of the successive analysis of word after word, with little attention to the problem of fusing the words into large units of meaning. Pupils taught by such a method seldom miss a word. No such difficulties as were exhibited by Subject 10 in Plate XV appear with a method placing much emphasis upon word-analysis. But it does produce a mechanical, word-pronouncing process which must ultimately be overcome before maturity is reached.

PLATE IX



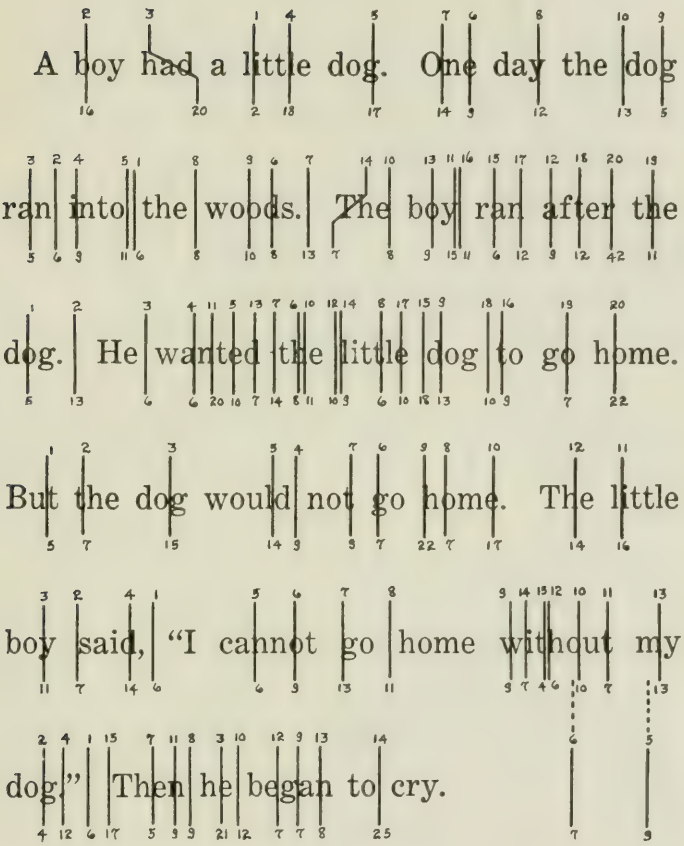
Silent reading by Subject 11, Grade I A, first test

PLATE X



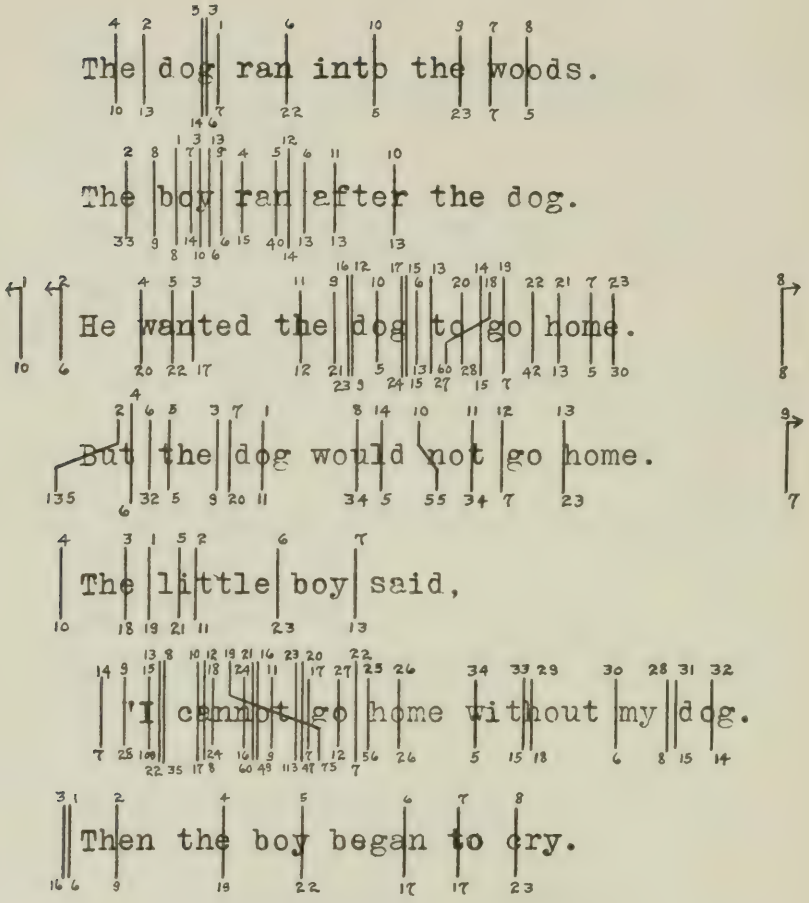
Silent reading by Subject 11, Grade I A, second test

PLATE XI



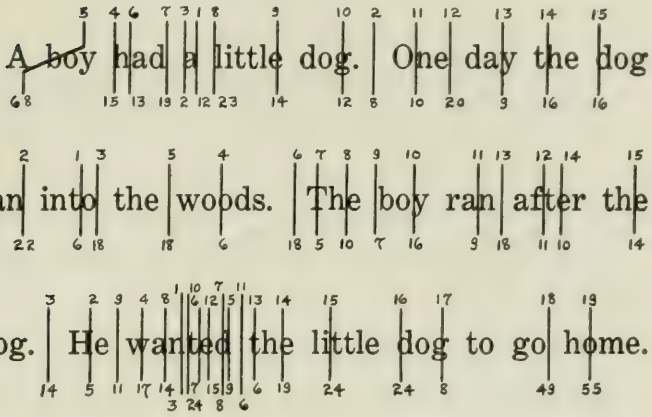
Silent reading by Subject 11, Grade I A, third test

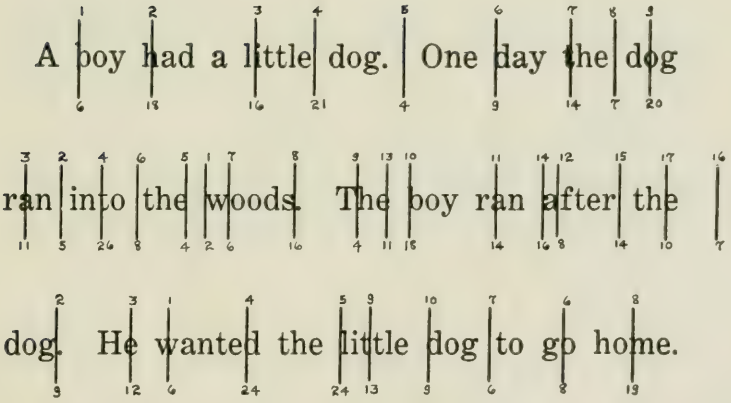
PLATE XII



Silent reading by Subject 13, Grade I A, first test

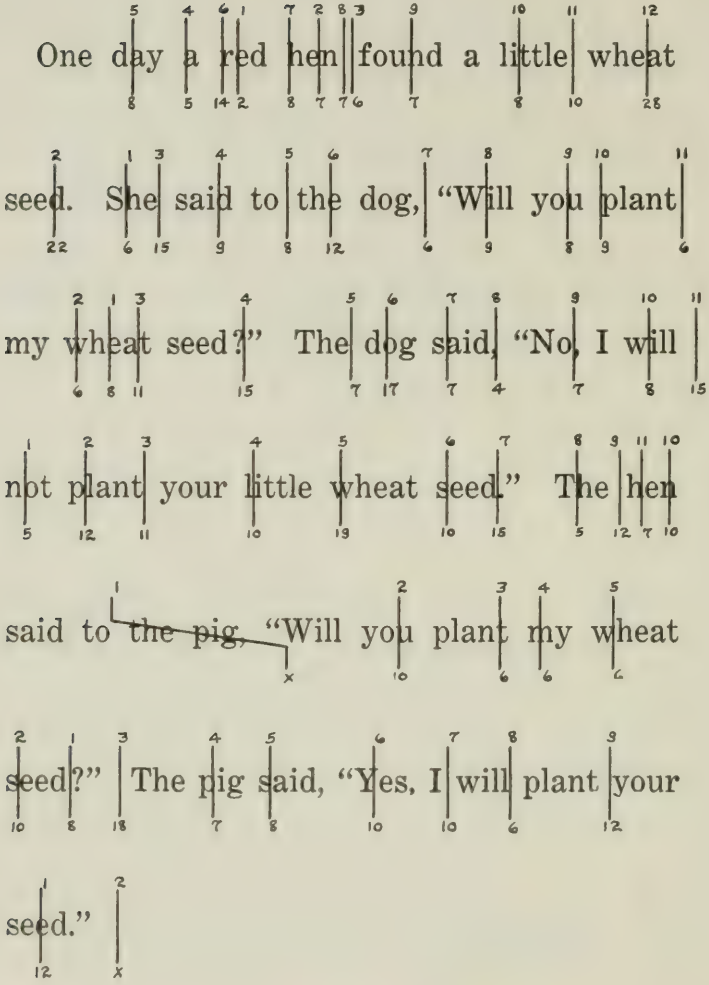
PLATE XIII





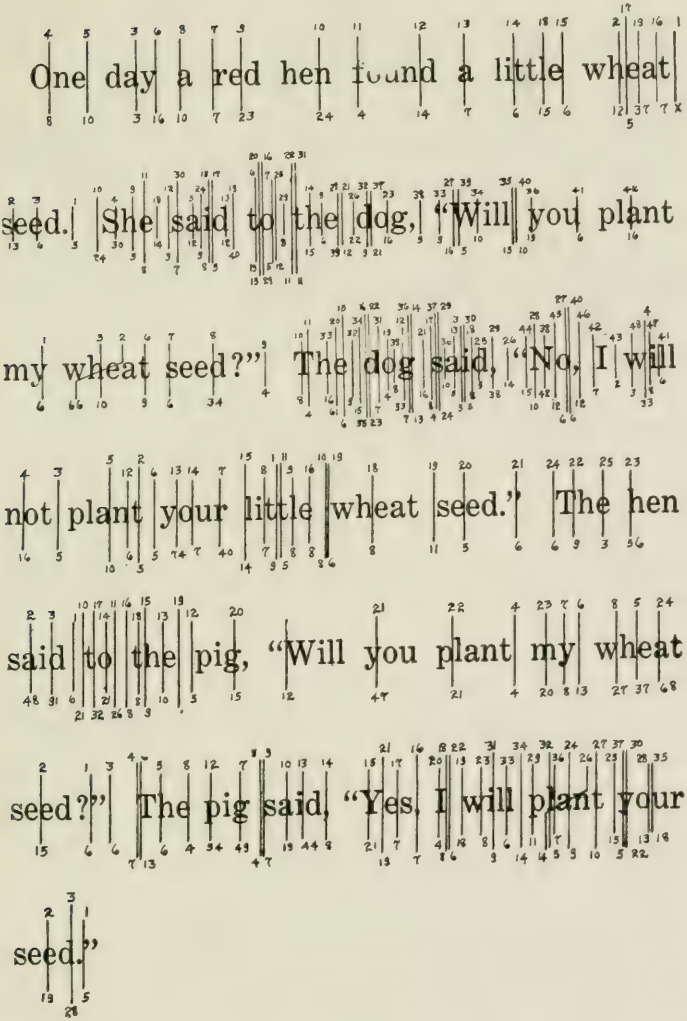
Silent reading of Subject 13, Grade I A—second test, above; third test, below.

PLATE XIV



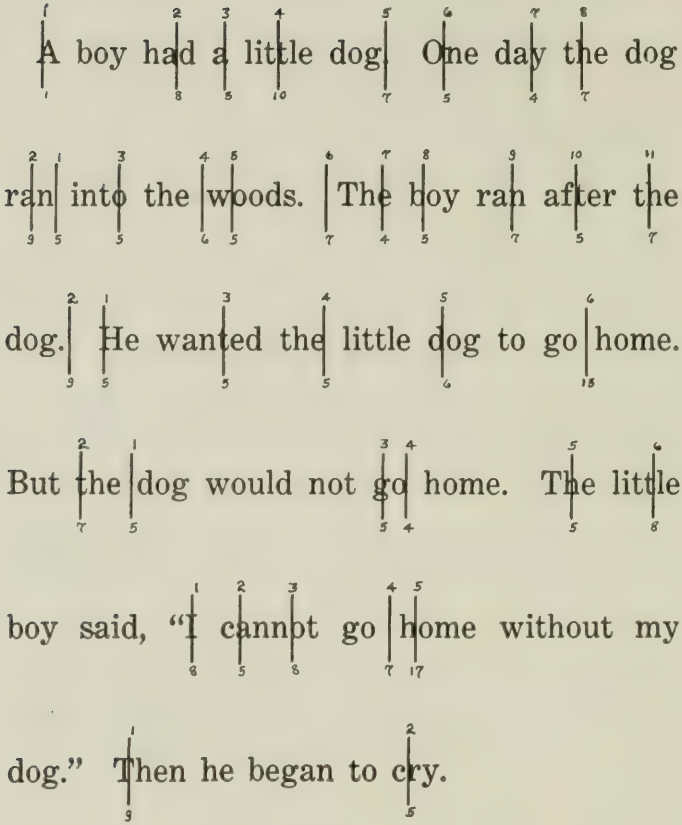
Oral reading by Subject 194, Grade I A

PLATE XV



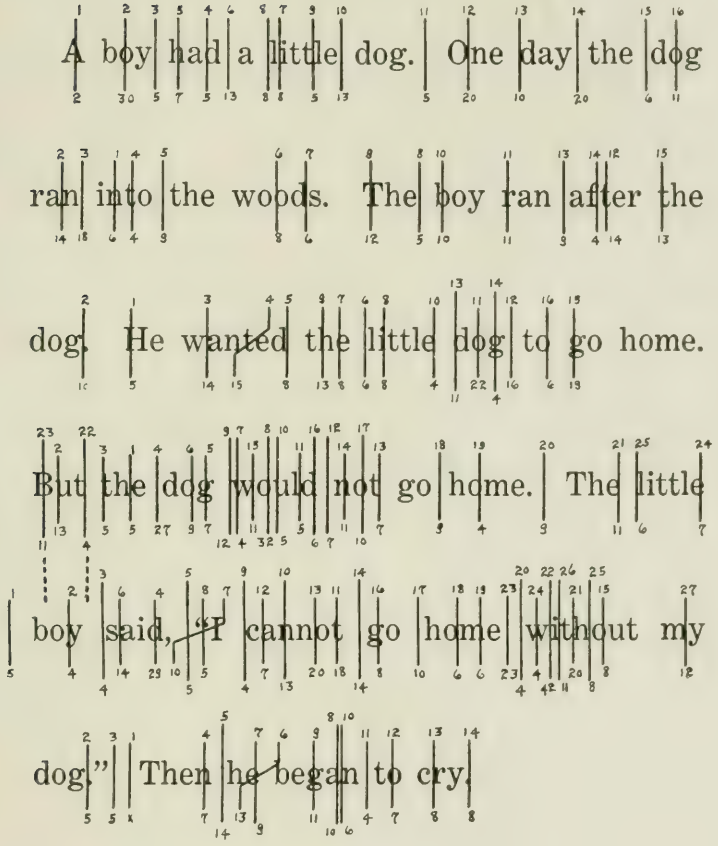
Oral reading by Subject 10, Grade I A

PLATE XVI



Silent reading by Subject 15, Grade I A

PLATE XVII



Silent reading by Subject 19, Grade I A

The cases described in the foregoing paragraphs show that the first grade is a period of decided growth for the elements of span of recognition, duration of fixations, and regularity of procedure across the lines. They also indicate the wide variations which exist among different pupils in these different elements. These variations in the early development of eye-movement habits are very significant. They show clearly that from the very beginning children are taking different routes toward maturity. One child may make his first step by the development of a correct attitude toward reading at the expense of word-recognition or eye-fixations. Another may begin by developing a habit of giving careful attention to the process of following the lines, word by word, perhaps at the expense of gaining larger units of meaning. Another pupil may develop a comparatively high degree of ability in word analysis, and at first may even fail entirely to take a correct attitude toward the total reading process. Some pupils just develop broad recognition units; others begin by developing speed in dealing with narrow units. The most characteristic fact about the first-grade records is the variation which exists. Apparently there is no single route which pupils must follow in order to reach finally mature habits in reading.

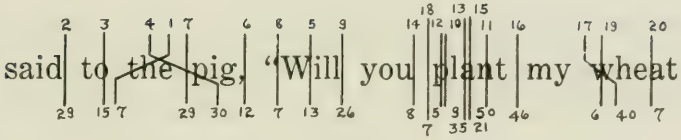
The analysis of first-grade reading indicates that pupils are starting out in many different directions. The last records of the I A pupils show that the treatment of the school has tended to draw most of them back into a normal trend of development. Sooner or later all must be drawn back in the general direction which leads to maturity. Those pupils who insist in going off on a tangent will, if they continue, become pathological cases in certain of the elements which enter into reading. Others less extreme make up the class of poor readers. The nature of poor reading in the intermediate grades can be better understood if it is considered simply as the natural outcome of the continuation of a wrong start in certain elements of the process.

DEVELOPMENT OF INDEPENDENCE IN WORD-RECOGNITION

An analysis of the records of first-grade children shows that one of their most common difficulties is caused by the lack of well-developed habits of word-recognition. If a dictaphone record of the oral reading of a selection is placed beside the corresponding eye-movement record the results of the lack of word-recognition are seen much more clearly. To illustrate the results of this form of analysis the records of four first-grade cases will be described.

Plate XVIII gives the record of one line of the oral reading of Subject 182, a pupil in the I A grade. In this record the most noticeable

PLATE XVIII



Oral reading by Subject 182, Grade I A

characteristic is the accumulation of eye-fixations upon the word "plant." The dictaphone record shows a hesitation after the words "will you" followed by a repetition of those two words, which gave time for the careful examination of "plant" before its pronunciation was attempted. This is a typical response to a mild difficulty. The word was mastered, but not without a careful analysis.

Plate XIX gives one line from the oral record of Subject 2, a pupil in Grade I B. The dictaphone record of this line shows that the subject omitted the word "little" and repeated the word "the." The period of confusion began when the word "wheat" was encountered at the ninth fixation. In the attempt to recognize "wheat" and "seed" the word "little" was forgotten, the reading of the whole line being confused. This line furnishes a good example of the fact that very often when an unfamiliar word is encountered it not only causes difficulty in the recognition of that word but radically modifies the subject's reading habits for the whole line. This subject read the two preceding lines in 9 and 14 fixations, respectively, and the two following lines in 19 and 11 fixations. This general confusion and breaking down of established reading habits are the most serious aspects of the lack of word-recognition.

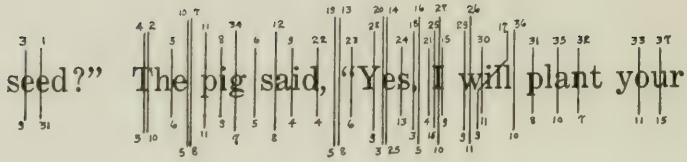
One line from the oral record of Subject 1, a very immature reader in the I B grade, is shown in Plate XX. This subject was a very slow, deliberate reader, who gave the same expression to every word and apparently got little sense of meaning from what she read. When she came to the word "yes" she hesitated for 4.2 seconds before she pronounced it. The confusion caused is clearly evident from her eye-movements.

Plate XXI gives the eye-movement record of three lines from the oral reading of Subject 12, a pupil from Grade I A. The second line of the record was read with little difficulty and no hesitation. His eye-movements on that line are few in number and regular in order. As compared with it, the record on the last two words of line 1 makes a decided contrast. The dictaphone shows the insertion of an extra word between "little" and "wheat" with a pause of 6.2 seconds between the two words. The word "wheat" was the particular cause of the difficulty. In the third line the same type of confusion is evident in the eye-movement record when the words "The dog said" were encountered. By referring to the dictaphone it was found that the pupil read as follows: "The dog – – dog – – said – – – – – – – dog said, No, I will – – – – ." Between the first "dog said" and the last "dog said" a

PLATE XIX

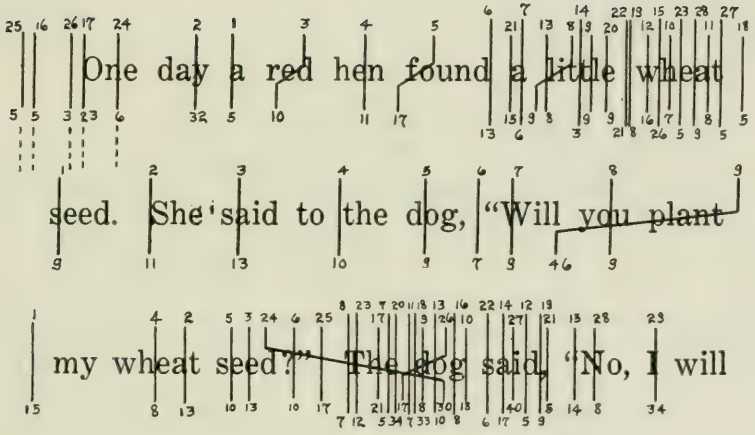
Oral reading by Subject 2, Grade I B

PLATE XX



Oral reading by Subject 1, Grade I B

PLATE XXI



Oral reading by Subject 12, Grade I A

period of 7.2 seconds elapsed. During that time the eye was busily engaged in trying to unravel the difficulties.

In oral reading, whenever such a confusion of eye-movements occurs, reference to the dictaphone record invariably corroborates the fact that there is confusion in getting the meaning, frequently caused by lack of word-recognition, but sometimes caused by difficulties in recognizing the thought expressed by combinations of easy words. In silent-reading records there is no objective means of confirming the existence of difficulties apparent in eye-movements. However, there are no reasons for believing otherwise than that difficulties, similar to those in oral reading, exist in the thought-getting processes of the reader. In Plate XXII, which shows the silent reading of one line by Subject 12, it is difficult to give any other interpretation than that here again the subject is experiencing a considerable amount of mental confusion, caused at first by encountering the words "little dog."

WORD-CALLING VERSUS RHYTHMIC EXPRESSION IN THOUGHT UNITS

Attention has already been called to the contrast between thought-getting and word-calling processes in reading. In order to get an objective measure of the character of the thought-getting process in oral reading, the rhythm of the unit of vocal expression was measured. To accomplish this, a dictaphone record of the reading was secured, from which the intervals between each word were transcribed upon a smoked-paper kymograph record. In this manner it was possible to determine the exact interval between the pronunciation of each word. This affords an objective index which shows whether a subject reads by grouping the words into their natural thought units, or whether he reads by the mere process of word-calling.

A record, secured in the manner just described, is shown in Figure 15 for the oral reading of Subject 1, a pupil in Grade I B. The heavy horizontal lines represent sections of a continuous time-line in reading the selection, while the black spots represent the location on the time-line of the pronunciation of the words. The time scale is shown at the base of the diagram, in units of one-fifth of a second. The figure should be interpreted in the following manner. The first three words were read at equal intervals during the first second of time, then followed a pause of two and four-fifths seconds, after which the next four words, "little red hen found," were read. A time interval of three-fifths of a second elapsed before the next words "a little seed" were spoken. There was

PLATE XXII

Silent reading by Subject 12, Grade I A

then a long pause of three and four-fifths seconds before the pupil read the words "she said," another pause of three seconds before the next

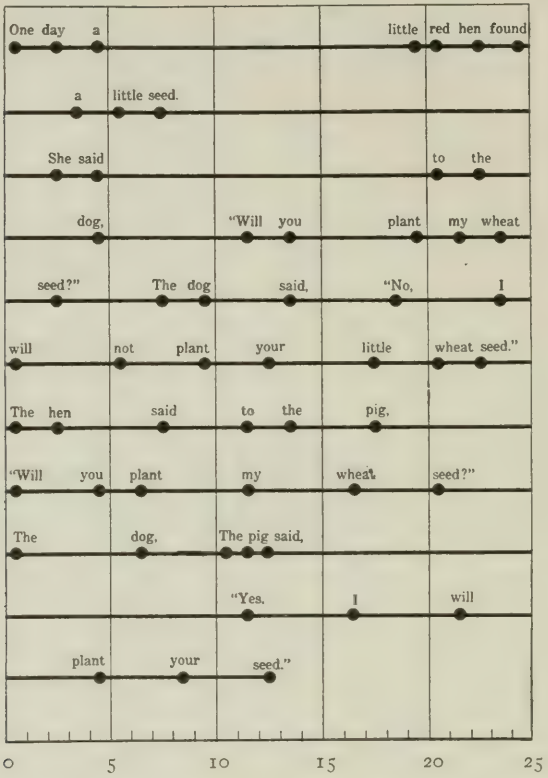


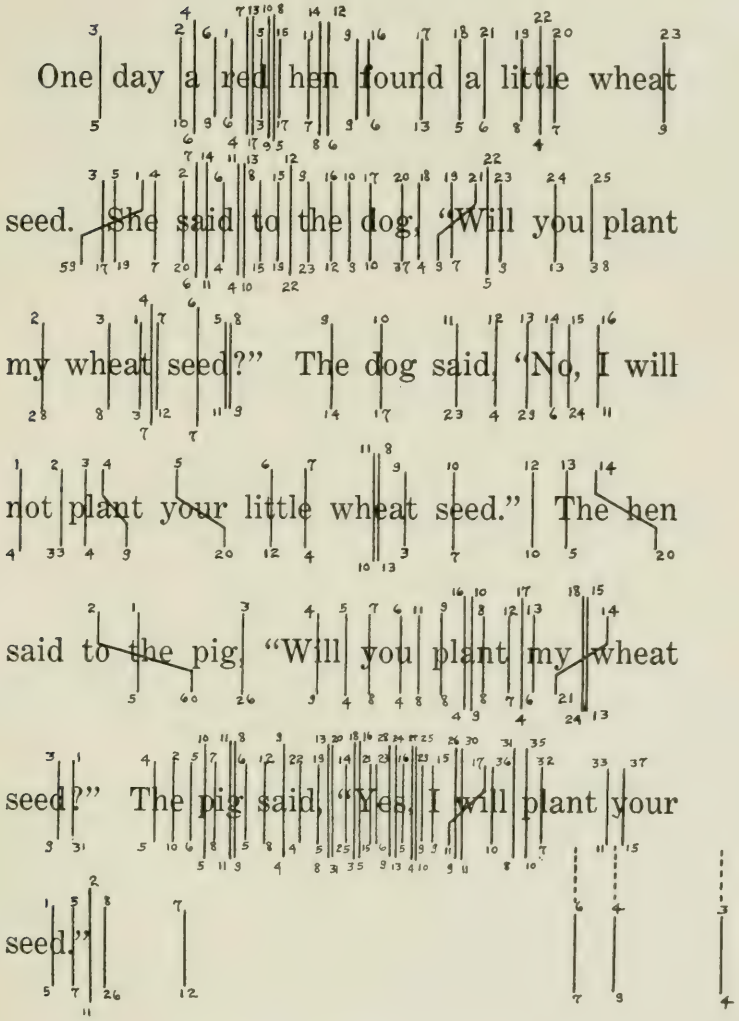
FIG. 15.—Rhythm of expression of Subject 1, Grade I B. Time record in one-fifth-second units shown on horizontal axis. Spots show position of word pronunciations.

word, etc. Or, to read the entire paragraph with a rhythm such as this subject used would be somewhat as follows:

One day a – – – little red hen found – a little seed. – – – – She said – – – to the – dog, – "Will you – plant my wheat – seed?" – The dog – said, – "No, – I – will – not – plant – your – little – wheat seed." The hen – said – to the – pig, – – "Will – you plant – my – wheat – seed?" – The – dog – the pig said, – – – – – "Yes, – I – will – plant – your – seed."

The rhythm of expression clearly indicates that this subject was reading in word rather than thought units. A comparison of the voice

PLATE XXIII



Oral reading by Subject 1, Grade I B

record with that of the eye-movement photograph, which is shown in Plate XXIII, throws much light upon the reading process of this pupil. In the first line the cause of the long pause in the voice record is better understood when one sees what the subject's eyes were doing. The word "red" evidently presented considerable difficulty, although the fact that the subject inserted "little" before it suggests that the association "little red hen" was exerting undue influence and that the memory of the original story was causing confusion. The many fixations in line 2 of the eye-movement record accompany the irregular rhythm of the reading of that line. The last sentence furnishes a fine example of pure word-calling with no rhythmic expression. Here again the thirty-seven

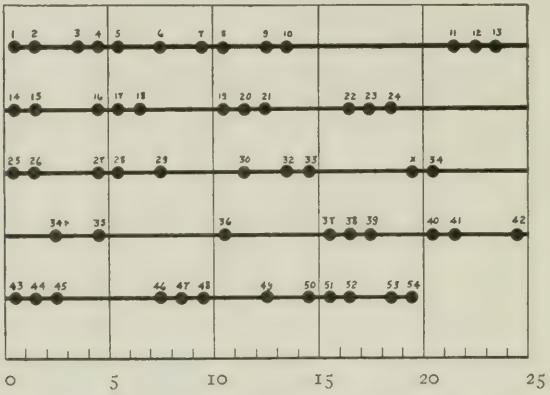


FIG. 16.—Rhythm of expression of Subject 14, Grade I B. Time record in one-fifth-second units shown on horizontal axis. Spots show position of word pronunciations.

eye-movements required in reading the sixth line indicate the confusion in the process of perception and the small-unit attack upon the sentence.

In Figure 16 the voice record of a mature first-grade reader is shown. Because of the small interval between many of the spots it is impossible to print the corresponding words in parallel. Consequently each dot is numbered to correspond to a word, the key for the numbers being given in Plate XXIV. The eye-movement record for the oral reading of this subject is shown in Plate XXV. This pupil is obviously a very different type of reader from the one described in the preceding paragraph. The arrangement of spots in Figure 16 shows a consistent attempt to group the words into thought units. By examining the successive groupings of spots it will be seen that the rhythm of expression was as follows:

PLATE XXIV

1 2 3 4 5 6 7 8 9
One day a red hen found a little wheat

10 11 12 13 14 15 16 17 18
seed. She said to the dog, "Will you plant

19 20 21 22 23 24 25 26 27
my wheat seed?" The dog said, "No, I will

28 29 30 31 32 33 34 35
not plant your little wheat seed." The hen

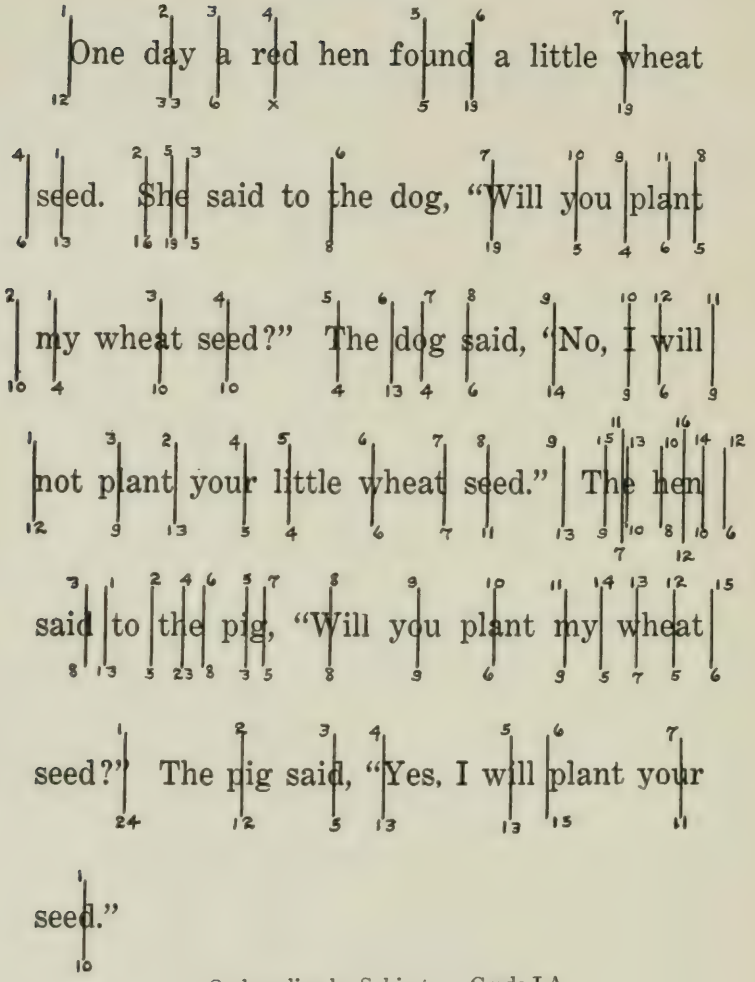
36 37 38 39 40 41 42 43 44
said to the pig, "Will you plant my wheat

45 46 47 48 49 50 51 52 53
seed?" The pig said, "Yes, I will plant your

54
seed."

Index numbers for words in first-grade selection

PLATE XXV



Oral reading by Subject 14, Grade I A

One day – a red hen – found – a little – wheat seed. – – – She said to – the dog, – "Will you plant – my wheat seed?" – The dog said, – "No, I – will not – plant – your – wheat seed." – Then the – the hen – said – to the pig, – "Will you – plant my wheat seed?" – The pig said, – "Yes, – I will plant – your seed."

The only point of confusion appears at the end of line 4, where the word "then" was inserted and the word "the" was repeated. This is the only place in the record where a marked irregularity of eye-movement occurs, 7 eye-fixations, 3 of which were the result of regressive movements, being required to read the words, "The hen." Both the voice and eye records indicate a considerable degree of maturity for a first-grade subject.

Figure 17 shows the voice records of thirteen different subjects in reading the first sentence of the paragraph. In this figure each horizontal line represents a single subject, whose index number appears at the left of the line. The first line shows the rhythm of reading for Subject 195, a university graduate. This subject read the sentence rapidly with the following type of word grouping: "One day – – a red hen – – found – – a little wheat – seed." The third line in the figure, for Subject 13, shows a very different rhythm, as "One day – a – hen – found a little – wheat seed." Other subjects show still other habits of word groupings, Subjects 17 and 182, for example, exhibiting little rhythm of any type, but instead a mechanical process of word-calling. The last four subjects furnish clear examples of the lack of word-recognition. Subject 20, the fourth line from the bottom, had to study 4 seconds on the word "seed," while the last subject, Number 181, found both the words "wheat" and "seed" difficult.

Frequently the reading of the first line in the sentence fails to show a natural rhythm, due to the difficulty of getting adjusted to the nature of the material. Consequently, a spot-diagram showing the word intervals in a sentence selected from within a paragraph might give a more valid series of word grouping. Figure 18 gives the records of fourteen subjects in reading one whole sentence and part of another selected from within the paragraph. The sentences used were "The hen said to the pig, 'Will you plant my wheat seed?' The pig said . . . . ." The words corresponding to the numbers above the dots may be identified by reference to Plate XXIV. The interval between words 45 and 46 corresponds to the interval between the sentences. This is a point of interest, because a clear recognition of sentence thought units should produce a somewhat longer interval here than at other

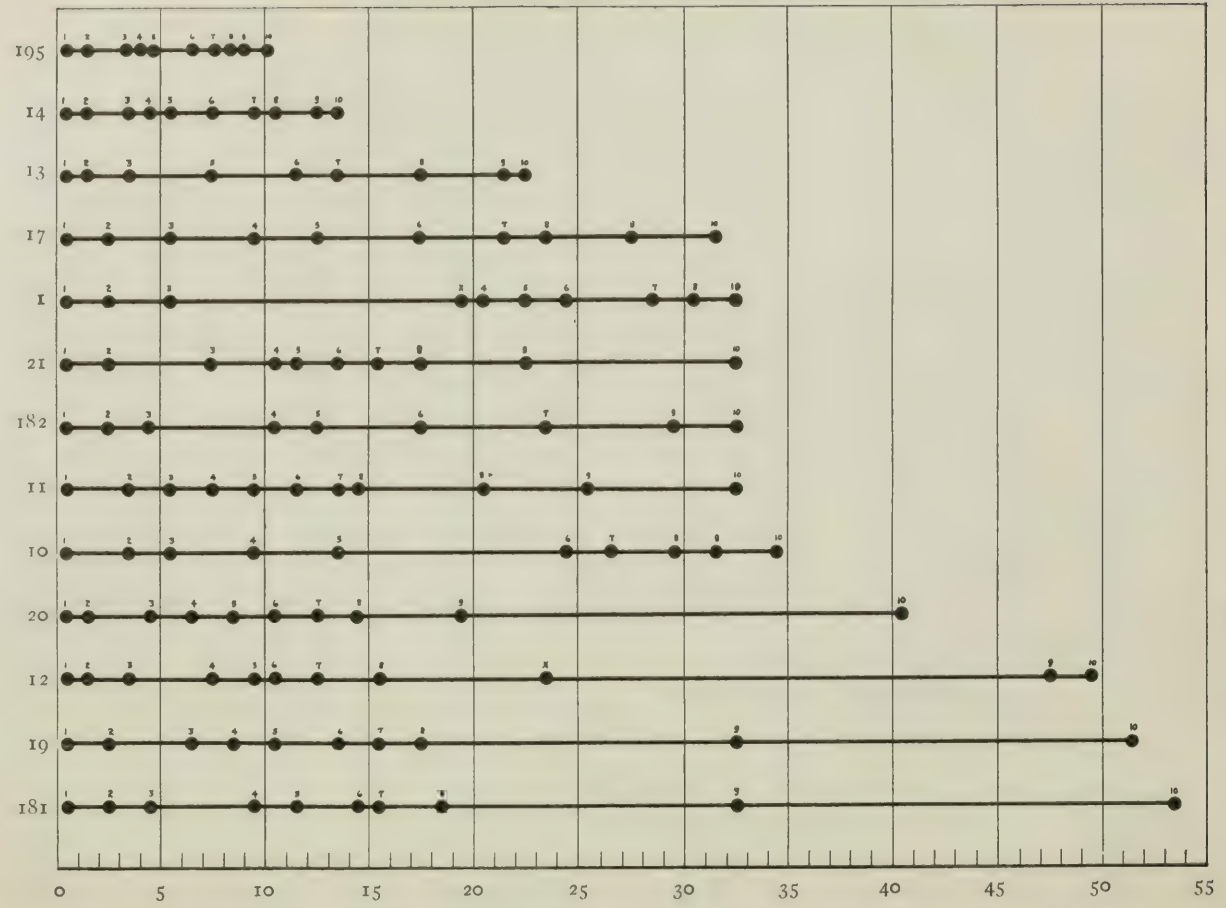


FIG. 17.—Rhythm of expression of thirteen first-grade subjects in reading first line of paragraph. Time record in one-fifth-second units shown on horizontal axis; individual subject numbers shown on vertical axis. Spots show position of word pronunciations.

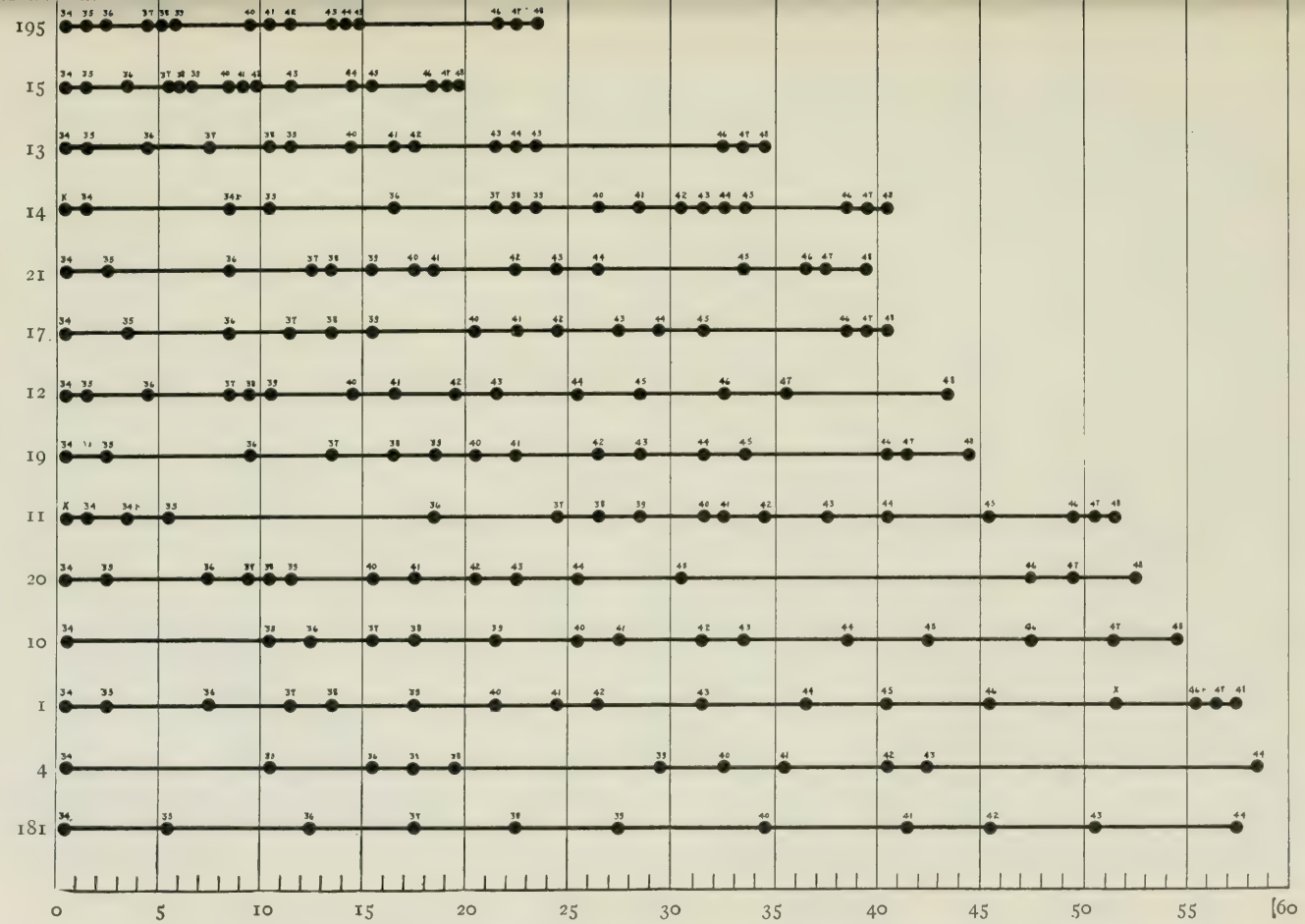


FIG. 18.—Rhythm of expression of fourteen first-grade subjects in reading lines within paragraph. Time record in one-fifth-second units shown on horizontal axis; individual subject numbers shown on vertical axis. Spots show position of word pronunciations.

points on the line. The record of the adult subject, Number 195, shows a definite grouping of words into thought units, with a longer interval between words 45 and 46. The record of Subject 15, a mature first-grade reader, also shows a distinct tendency toward grouping. Subject 21 gives little attention to the end of the sentence, showing a smaller interval between words 45 and 46 than between words 44 and 45. The record of Subject 181, the last in the figure, exhibits almost a perfectly mechanical process of word-calling, moving at the rate of one word per second. At only one point does he miss this regular rate. This subject was a I B pupil from the public school. Certainly for him the degree of word fusion into thought units must be exceedingly small. He furnishes an extreme example of the result of a method of teaching which is primarily concerned with words.

A careful examination of the spot-diagrams shown in the last four figures makes possible an objective analysis of rate of reading which is far more productive than a simple statement of average number of words per minute. Rate of reading is a complex, determined by many elements which may vary independently. For example, although two readers may have the same average rate, an analysis may show that one reads with an excellent rhythm except for a few long pauses caused by encountering words which cannot be easily recognized, while the other reads with no rhythmic grouping at all, but makes up for his slow and mechanical expression by a well-developed habit of word-recognition which enables him to avoid any long pauses caused by unfamiliar words. Or from the standpoint of eye-movements, the same rate may be produced by a combination of short fixation pauses and a narrow recognition-span or by a combination of long fixation pauses and a wide-recognition span. The improvement of the rate in two such cases would, however, require exactly opposite modes of treatment. Such records as have been shown in this chapter should emphasize the fact that detailed qualitative analysis will make possible a type of diagnosis which can never be secured by a quantitative manipulation of complex scores. If the degree of rhythmic expression in oral reading can be accepted as one index of the ability to group words into meaningful units, the method just described can be applied as a measure of the degree of maturity of reading habits.

The present chapter has been concerned with two outstanding facts: first, that groups taught by various methods show decided contrasts in the development of the different elements which make up the reading process; second, that even within a given group individuals show pronounced differences in both the order of development and the rate of development of the various reading elements.

As has been pointed out in the first part of this chapter, the different methods of teaching cannot be evaluated in terms of the results in the first grade. The analyses which have been made simply show what are the immediate results of the respective types of teaching. Since all methods of instruction in reading have for their ultimate goal the attainment of mature reading habits, an analysis at any particular stage will show which elements have and which have not been developed, and how far the growth in each case has progressed.

The psychologist can state the case to the teacher somewhat as follows: A study of mature readers shows the stage of development toward which the school is moving. Such a final stage may be reached by various methods. However, regardless of the method used, certain fundamental habits must ultimately be developed. It is the function of the teacher to say when and how rapidly the development can best be accomplished. It is the function of the psychologist to determine by careful analysis what are the fundamental elements and what is their condition of maturity. If the analysis can be carried far enough to plot the normal growth curves under ordinary school conditions, then the teacher can use the results of analysis very effectively.

A case from the present chapter may be used for purposes of illustration. Out of the group of twelve children from the I B grade of the University laboratory school, five were unable at the end of the first semester to read accurately the modified "Little Red Hen" story. Furthermore, they had not reached the stage of development where their eyes followed the lines of print in a careful manner while they tried to read. They had, however, developed a very active concern for the meaning of the passages which they tried to read and, in general, when they failed to read the story properly they supplied a content of their own which was meaningful. On the whole, their attitude toward reading was mature to the point that they recognized clearly that the story had something to tell and that it was their business to find out what it was. Their lack of proper eye-movement habits and their inability to cope with new words prohibited them from getting the meaning accurately; but their attitude toward the process was more mature. In terms of the analogy of the skyscraper, this method evidently considers reading attitude in the same manner in which the contractor considers the steel structure. By its procedure this method would say that a correct attitude toward reading is of such great importance that it should be pushed a long way toward maturity, letting the other habits rest for the time being. With only the evidence which has so far been presented, the psychologist has no criticism of this

method. He can, however, say to those using this method that sooner or later the eye-movement habits and the word-recognition elements must be developed and that finally they must become just as mature as the element of reading attitude.

The advocates of the other method which places first emphasis upon word study could be given the same principle. Habits of word study may be developed first, but ultimately a correct reading attitude must also be secured. This is not equivalent to saying that any method is as good as any other. It is simply stating that a method cannot be accurately evaluated by a cross-section view at the level of any particular grade. In the absence of sufficient data covering the entire interval from the beginning stage to that of maturity, a final evaluation is not in order. What the teacher can do is to use the results of analysis to determine the stages of maturity in the fundamental elements of reading. As a result she will be able to say that in certain elements her pupils are making normal progress; that in other elements they are considerably nearer the ultimate goal of maturity than is normally the case in that particular grade; while perhaps in still other elements her pupils are relatively immature and will need a large amount of exercise. To make the matter concrete, the teacher might raise such questions in regard to her method and results as the following:

1. What kind of an attitude toward reading do my pupils have? Do they consider reading as a process of gaining meaning or of pronouncing words? When, according to my method, should I expect a correct reading attitude to be attained?

2. Do my pupils' eyes follow the printed lines in regular order as they read? Do they depend upon their perception of the words or their memory of the story for their meaning?

3. Are their habits of word-recognition satisfactory for their stage of development? Are they able to master a new word by the method of phonetic analysis? When, in my method, should children be able to do this?

4. Is the span of recognition of my pupils developed up to the average for the grade? Do the pupils see words and phrases, or is their recognition unit smaller than a single word? Do they make many or few eye-movements in reading a single line?

5. Do they have habits of quick perception or are they slow in recognition? Can they read words from flash cards when presented at a rapid rate?

6. In observing their eye-movements can I detect many backward, oscillating movements, or is there regularity of fixation along the lines?

7. Do my pupils give evidence of fusing their words into large units of meaning, or do they read in a mechanical word-by-word manner? Does the rhythm of their oral expression display a recognition of thought units?

8. Does my method provide any specific exercise for deficiencies in these elements?

If the application of analysis produces no more immediate results than the serious attempt to answer the foregoing questions, its value will not be negligible.

While it is evident, from the flexible adjustments which pupils are able to make, that more than one method of teaching reading may succeed equally well in developing mature reading habits, one would not expect to find a large number of equally good methods. Certainly there can be no doubt that some methods are inferior and uneconomical. In the light of present school experience no one would attempt to justify the practice of using the alphabetic method of teaching reading, although pupils trained in this manner will eventually learn to read. As has been stated, the present investigation does not yield the type of data necessary for a judgment of methods, and consequently no attempt has been made to evaluate them. It should not be inferred from this that the psychologist is not interested in methods. The problem of determining which methods are superior and which are inferior is large and significant. It cannot be solved except by following particular groups of pupils through the different stages of growth toward maturity. Its solution will require the combined efforts of the teacher and the psychologist, the teacher trying out the various combinations of methods in the classroom under carefully controlled conditions, while the psychologist furnishes the scientific analysis of results which will show the degree of progress which has been made in each of the fundamental elements of reading. This is a productive field for a future co-operative investigation.

In chapter ii growth curves were presented showing the common rate of progress in certain fundamental reading elements. In the present chapter it has been shown how various methods of teaching cause pupils to take different directions in the development of the various elements. It will be the purpose of the following chapter to show the conditions which occasionally result when a pupil who starts on a devious, rather than a direct, route toward maturity is allowed to go off at a tangent for too long a time before being turned back toward the goal of maturity.

CHAPTER IV

INDIVIDUAL VARIATIONS AND SPECIFIC TRAINING IN READING

The growth curves which were presented in chapter ii show that throughout the elementary grades there is a constant approach toward maturity. These curves are based upon grade medians and therefore show the general tendencies of fairly large groups. While the successive grade medians indicate the nature of normal progress from grade to grade, an examination of the individual averages will show in many cases a considerable variation from the general grade norm. The nature of these individual variations can be best understood if they are considered simply as the logical outcome of the tendencies toward deviation which were apparent in the records of the first-grade pupils. The curves of growth show the route which is most commonly taken in the journey toward maturity. Deviations from this main line of progress mean that certain pupils are trying to reach the same goal by following a different road. Many of these pupils eventually are drawn back to the main line of travel. The pupils, if allowed to go far enough, develop reading habits which are so inconsistent with the demands of maturity that special measures have to be taken to turn them in the right direction. If some special measures are not taken these pupils ultimately become pathological cases and are unable to meet the ordinary standards of the school.

This report does not consider the cases of readers who are so deficient as to be classed as pathological. An elaborate study of school children who exhibit these pathological tendencies in varying degrees is provided in another monograph[1] of this series. It is the aim of the present chapter to present an analysis of a number of cases, selected from the different school grades, in which individual variations such as are commonly found in school will be studied, using the data for the entire group of pupils as a background.

A study of the photographic records shows that an individual pupil may vary from the median rating of his school grade in one, two, or all three of the fundamental characteristics of eye-movements. This means that one pupil may develop a habit of using a wide recognition-span

[1] W. S. Gray, *Remedial Cases in Reading: Their Diagnosis and Treatment*. "Supplementary Educational Monographs," No. 22. Chicago: Department of Education, University of Chicago, 1922.

and, as a consequence, be able to read with a comparatively small number of fixations per line. This mature type of habit may, however, be accompanied by a lack of regularity in the order of the fixations or by a very slow fixation time. On the other hand, another reader may reach the same level of reading maturity by using habits of rapid recognition and regular rhythmic eye-movements, but at the same time having a very narrow recognition-span, making many fixations per line.

It has frequently been assumed that some such compensating relationship as this exists in the majority of cases, and that most often the reader who has a broad recognition-span consumes a correspondingly greater amount of time per fixation. A study of the facts reveals that this assumption is entirely unfounded. The correlation between the average number of fixations per line and the average duration of fixations for the silent reading of eighty-three subjects in Grades II to VI, inclusive, is r = (Pearson) $+.49 \pm .056$. It must be remembered, however, that during these grades a large amount of improvement in both elements is occurring. This would have the effect of causing the correlation coefficient to be considerable higher than would be the case if the element of growth were eliminated. An indication of the influence of this growth factor can be seen from comparing the correlation for Grades II to VI with that for the high-school Juniors taken alone. The correlation between average number of fixations per line and average duration of fixations for the nineteen subjects in the Junior class is $-.08 \pm .055$. The significance of this practically zero correlation is that the two elements are almost entirely independent, which means that a wide recognition-span may be accompanied by a long, medium, or short fixation time. It is possible, therefore, for a reader to make normal progress in one element while the other may be greatly under- or over-developed. A reader may be equally mature in size of recognition-span, average rate of recognition, and regularity of eye-movements across the printed lines. On the other hand, an individual may exhibit any one of nine possible combinations of maturity in these three elements of reading. This provides for a large degree of flexibility in meeting the varied types of difficulty in reading.

The nature of the individual variations can be presented more clearly by means of a diagram. In Figure 19 the score for each of the three characteristics of eye-movements is given for the individual pupils in the sixth grade. The numbers along the base line of the figure indicate the subject number of each pupil. The vertical axis gives a numerical scale which applied to line *a* indicates average number of fixations per

line; when applied to line *b* indicates average duration of fixation pauses; and when applied to line *c* indicates average number of regressive movements per line. The averages for each pupil are shown directly above the individual subject numbers. For example, Subject 103 made an average of 10.1 fixations per line, an average of 6.1 twenty-fifths of a second per fixation pause, and an average of 3.1 regressive movements per line. The next subject, Number 104, made an average of 8.8 fixations per line, an average of 5.4 twenty-fifths of a second per fixation, and an average of 1.9 regressive movements per line. The cases in

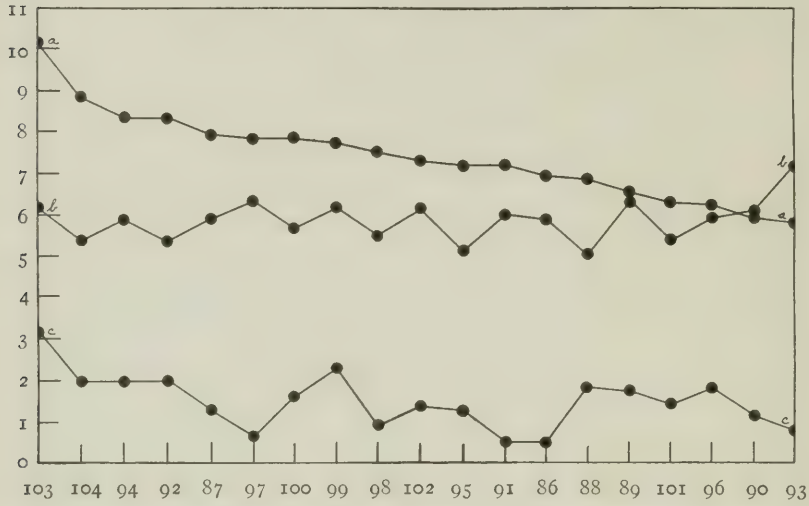


FIG. 19.—Individual variation from medians for eye-movements in Grade VI. Individual subjects shown on horizontal axis; units on vertical axis for curve *a* represent average number of fixations per line, for curve *b* average duration of fixation pauses, for curve *c* average number of regressive movements per line.

Figure 19 are arranged according to decrease in average number of fixations per line, as shown by the descending of curve *a*. The significant fact in the figure is that the average duration of the fixations and the average number of regressive movements per line show a large degree of independence in their relationship to average number of fixations per line. The grade medians for this group show that the norms are 7.3 fixations per line, 5.9 twenty-fifths of a second per fixation, and 1.6 regressive movements per line. The pupil who comes nearest to these norms is Subject 102, whose averages are respectively 7.3, 6.2, and 1.5. While this subject most nearly represents the central tendency of the

group, the entire group shows a great variety of combinations of the three characteristics of eye-movements. Subject 95 varies only slightly from the group median for average number of fixations per line, but shows a larger deviation in respect to average duration of fixations. Subject 93 has a much wider recognition-span than the median for the group, making only 5.7 fixations per line; but his average fixation time is much longer than the grade median, while in number of regressive movements he is more mature than the median pupil in the grade.

The scores of the different individuals plotted in Figure 19 indicate that there are a variety of possible adjustments by which a pupil may meet the demands of reading. The various elements which enter into the reading process may be developed in a very unequal manner.

In order to illustrate the significance of variation in any of these three elements of eye-movements, a number of individual cases will be studied in greater detail. The eye-movement averages of these pupils will be compared with the medians in the same elements for the corresponding school grades. Illustrative cases will be drawn from the second, third, fourth, and fifth grades of the elementary school, from the high-school Sophomore class, and from a senior college group.

Table XVII gives the medians of the average number of fixations per line, the average duration of fixations, and the average number of

TABLE XVII

GRADE MEDIANS FOR EYE-MOVEMENTS IN SILENT READING

	I B	I A	II	III	IV	V	VI	VII	F	So	J	Se	Col
Average number of fixations per line	18.6	15.5	10.7	8.9	7.3	6.9	7.3	6.8	7.2	5.8	5.5	6.4	5.9
Average duration of fixations.....	16.5	10.8	9.1	7.9	6.7	6.3	5.9	6.0	6.1	6.2	5.6	6.2	6.3
Average number of regressive movements per line..	5.1	4.0	2.3	1.8	1.4	1.3	1.6	1.5	1.0	0.7	0.7	0.7	0.5

regressive movements per line for silent reading in each school grade. These data are compiled from the medians given in Tables III, IV, and V. The table should be read as follows: The median number of fixations per line in Grade I B is 18.6; in Grade I A it is 15.5; in the second grade 10.7, etc. The medians for average fixation time and average number of regressive movements per line should be read in the same manner.

Since the majority of subjects in this investigation were chosen from the University of Chicago laboratory schools, the growth curves represented by these data probably show somewhat higher medians than would be expected from average public schools. An indication of the amount of difference which might exist may be gained from a comparison of a group of ten first-grade subjects from the public school with a group of eleven first-grade children from the University school. The medians for the public-school group and the University-school group, respectively, are as follows: for average number of fixations per line 18.5 and 17.0; for average duration of fixations 14.2 and 11.5; and for average number of regressive movements per line 4.8 and 4.5. The difference which exists shows that, at least on the first-grade level, the growth curves would not need to be greatly modified to be used for comparison with pupils from public schools. A comparison of a group of public high-school pupils with a similar selection from the University High School, shows little difference in the development of these elements of reading. While the writer does not urge the acceptance and use of the grade medians from this investigation for finally determined "standards" of eye-movements, nevertheless these medians will be serviceable as a basis of comparison in the analysis of individual cases. The shape of the growth curves, as well as the nature of the distributions at most of the grades, would indicate that the general characteristics of curves of growth based upon a larger number of cases would not be greatly different. With this understanding of the medians in Table XVII, comparisons will be made with a number of individual cases.

ANALYSIS OF ELEMENTARY-SCHOOL CASES

Second-grade subjects.—Three cases have been selected from the second grade to show the variation in the development of different reading elements at this level. These subjects illustrate three types of combination of eye-movement habits. Table XVIII makes possible a ready comparison of their records with the second-grade medians.

The first pupil to be used for comparison, Subject 38, is a second-grade boy with immature reading habits. A section of his eye-movement record for silent reading is shown in Plate XXVI. This subject makes an average of 20.5 fixations per line, while the median for his grade is 10.7 fixations. In this characteristic, therefore, the pupil is very much below normal. Since the principal cause of a large number of fixations per line is the existence of a narrow recognition-span, the photographic record shows at once that this subject's immaturity in

reading is at least partly due to lack of development in this element. The record in Plate XXVI also shows a very great irregularity in the reading of part of the lines. For example, the first line was read with 8 fixations while the fifth line required 39. The fact that one line could be read with 8 fixations is clear evidence that this subject's maximum or absolute recognition-span is considerably wider than the span which he habitually uses. The average number of fixations per line is an index of the normally used recognition unit, rather than of the maximum or absolute unit. It should be remembered that tachistoscopic experiments generally measure the maximum span; and that comparisons of the recognition units in reading as measured by average number of fixations per line with the average perception span as determined with

TABLE XVIII

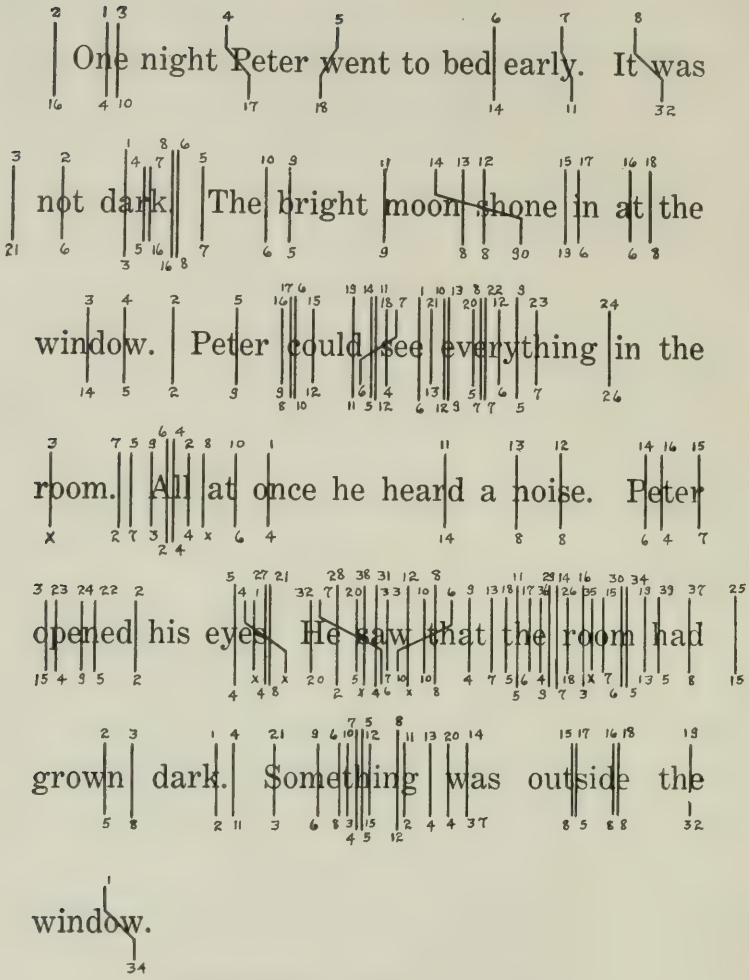
COMPARISON OF INDIVIDUAL RECORDS WITH MEDIANS, GRADE II

	Median for Grade II	Subject 38	Subject 37	Subject 25
Average number of fixations per line	10.7	20.5	6.1	10.1
Average duration of fixation pauses	9.1	9.5	9.3	12.2
Average number of regressive movements per line	2.3	8.5	0.6	2.3

the tachistoscope are actually dealing with two types of processes. The element which is of practical value in the reading process is the normally used recognition-span rather than the maximum, which is determined by a different kind of measurement. This distinction should be kept clearly in mind when exercises for developing a wider span are proposed. The problem of enlarging the normally used recognition unit is different from the problem of increasing the width of the maximum span. One would expect to find the possibilities in the former case much greater than in the latter, since the latter seems to be limited by native capacity, which cannot be increased.

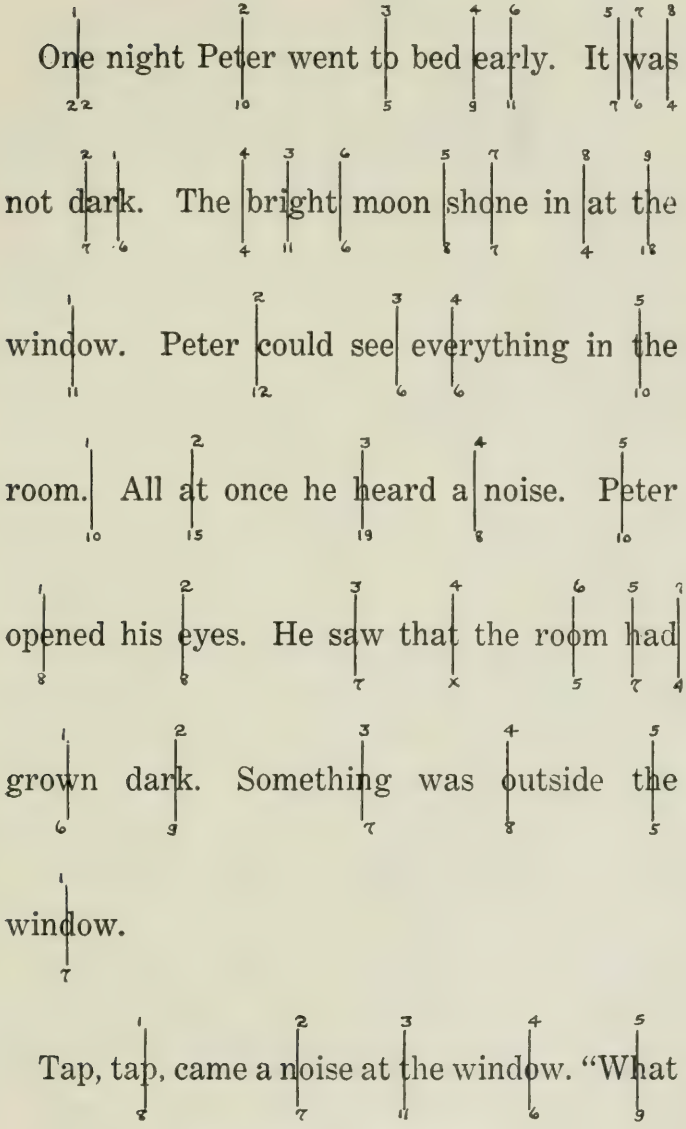
To return to the record of Subject 38, one finds that he has an average duration per fixation of 9.5 twenty-fifths of a second, while the median for his grade is 9.1 twenty-fifths. In this respect the subject is approximately at standard. Since the duration of a fixation is determined by the rapidity of recognition, regardless of the size of the unit perceived, it must be concluded that this pupil recognizes whatever unit of material

PLATE XXVI



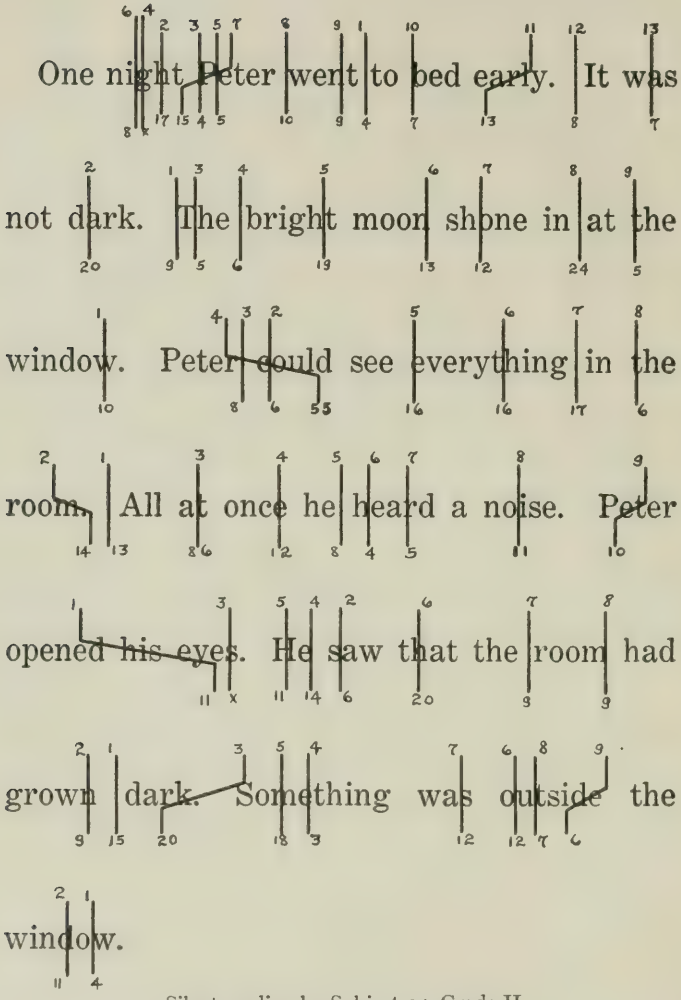
Silent reading by Subject 38, Grade II

PLATE XXVII



Silent reading by Subject 37, Grade II

PLATE XXVIII



Silent reading by Subject 25, Grade II

his eye takes in, whether it be a letter, word, or phrase, as rapidly as his stage of maturity warrants. Evidently one thing which he does not need is an emphasis upon speed in reading. If his perception span were widened, his rate of reading would automatically increase without a reduction in his average fixation time.

The data in Table XVIII show that this subject makes an average of 8.5 regressive movements per line while the grade median is 2.3 regressive movements. In this element, he exhibits one of his most serious defects. His general mental processes show evidence of confusion. If one examines carefully the order of fixations in line 3, he is aware of an utter lack of orderly and rhythmic progress across the line. One of the most noticeable defects in this subject's record is the lack of the habit of swinging the eye from the end of one line back to the very beginning of the next. In line 3 the eye drops from the end of line 2 down to the word "see" and then moves in the backward direction for fixation numbers 2 and 3 until the first word in the line is reached. This means that when the subject became confused he fell into his regular forward-moving type of habit while getting back across the line to the beginning. This same tendency is clearly shown in 7 of the 16 lines which he read. After he gets to the first word in line 3 he makes 8 additional regressive movements before he is ready to pass on to a similar process in the next line. The confusion of this subject could not have been produced solely by the lack of recognition of the simple words in this paragraph. It must be due rather to the lack of ability to synthesize or fuse the elements of the sentence into a whole. The subject is evidently finding it necessary to make a type of minute analysis which breaks up the habits of proceeding across the lines in a regular, rhythmic manner. He makes an average of more than three times as many regressive movements per line as the median pupil in his grade.

To sum up Subject 38, it is clear that in speed of recognition, as evidenced by the average duration of his fixations, his record is practically normal. However, in width of recognition-span and in regularity of fixation pauses he is so clearly deficient that it would seem advisable to apply a series of specific training exercises for the development of these elements. In his journey toward maturity this subject has departed so far from the path of normal progress that his general improvement in reading can go little farther until certain elements are brought back into line.

The next case to be presented, Subject 37, is a pupil from the same school grade but with much more mature reading habits than those of

the pupil just described. The first paragraph from this subject's eye-movement record is given in Plate XXVII. It shows at a glance a very regular and systematic set of habits.

Reference to Table XVIII shows that Subject 37 has an average fixation time of 9.3 twenty-fifths of a second, which is approximately the same as the second-grade median. However, her average number of fixations per line is only 6.1 as compared with 10.7 which is the grade standard. In average number of fixations per line this second-grade pupil makes a record not surpassed by the median subject in any grade below the high school. In respect to average number of regressive movements per line she shows even more mature habits. Her record shows an average of 0.6 regressive movements per line as compared with 2.3 which is the norm for the second grade. Her record in this element is not surpassed by any median below the college level. This must be interpreted to mean that in reading simple material of the character of this selection, this subject exhibits a recognition-span and a type of rhythmic eye-control which is far superior to the median of her grade. Although silent-reading test scores were not available for second-grade subjects, it is interesting to note that in the Gray oral test this subject stood highest in the grade.

Subjects 37 and 38 are in the same reading class. A comparison of their records causes one to raise a question in regard to the value of giving each the same type of reading work. Subject 37 has progressed far beyond her school grade in the elements of span of recognition and regularity of eye-movements across the printed lines. In speed of recognition she is practically normal. The logical conclusion would be that this subject has progressed far enough in these elements for the time being, and that emphasis should be placed upon some other type of element which may be less well developed. A broad reading experience which would be rich in content value would probably come much nearer meeting her needs than continued drill upon mechanics.

A case whose diagnosis reveals a still different combination of reading habits is that of Subject 25, who is also in this same second grade. Table XVIII shows that in respect to average number of fixations per line and average number of regressive movements this subject is very close to the standards for his grade. In respect to the average duration of fixations, however, he is considerably below normal, taking approximately 33 per cent more time per fixation than the median pupil in the second grade. His case is practically the reverse of Subject 38, the first pupil described in this chapter. The record of eye-movements

for Subject 25 is given in Plate XXVIII. The diagnosis of this case, as far as eye-movement habits are concerned, would indicate that only in respect to the length of fixations is there notable variation from the general trend of the group. Here it is evident that some exercises, perhaps in the nature of modified flash-cards, are needed to reduce the duration of fixations. If his fixation time could be reduced to average, the subject would be normal for his grade in all three respects.

The three second-grade cases just described indicate the extent of the variation from the normal growth curves which may result from a continuation of some of the extreme tendencies which are noticeable in the first grade. Subject 38 shows a decided deviation from normal in span of recognition and regularity of progress across the printed lines, this deviation being in the nature of a lack of development, while Subject 25 is below normal in average duration of fixation pauses. Although one would not expect to find a purely symmetrical development in these eye-movement habits for all cases, it is clear that a conspicuous deficiency in any of these elements means that sooner or later the subject showing such deficiency must make a considerable improvement in the direction of normal progress toward maturity. A study of eye-movements, therefore, affords one basis of diagnosis for certain elements of reading, while the results of such diagnosis are suggestive of the type of remedial work which may at some time be needed. Since it is possible to define in a fairly definite manner the final goal of maturity, a pronounced deficiency in any of the elements which are fundamental to final maturity can be interpreted to indicate the desirability of certain types of remedial exercises. Unless the deficiency is very great it may be remedied by the ordinary work of the class. However, in case of a very decided deficiency some specialized exercises may be required to help the pupil to bring a particular element nearer to normal. All of these cases furnish examples of the need of detailed scientific analysis followed by specific teaching.

Third-grade subjects.—The two subjects whose cases will be next presented for analysis were selected from the third grade. Their averages, together with the third-grade standards, are shown in Table XIX.

Subject 52, whose eye-movement record is shown in Plate XXIX, ranked next to the lowest in his group as measured by the Monroe Silent Reading Test, and about normal by the Gray oral test. His averages for the three characteristics of eye-movements, as shown in Table XIX, are below the grade medians at every point, resembling the second-grade standards more than those of the third grade. He shows

a general retardation in his reading habits. He needs training which will give him a wider recognition-span with a shorter duration time, and in addition a development of the habit of regular eye-movements across the lines. His record as shown in Plate XXIX gives evidence of mental confusion. At the end of line 2 his difficulty could not have been caused by lack of word familiarity since the words at that point are all extremely simple. It is clearly the lack of mental assimilation of the fused meaning of the words which causes the radical change in his eye-movements when the word "the" is reached. In line 6 another confusion period occurs, the combination of words "Something was outside" causing the difficulty. In the remaining thirteen lines of this subject's record, which are not shown in the plate, there are seven lines which contain confusion periods similar to that shown in line 6 of Plate XXIX. The subject

TABLE XIX

COMPARISON OF INDIVIDUAL RECORDS WITH MEDIANS, GRADE III

	Median for Grade III	Subject 52	Subject 47
Average number of fixations per line	8.9	11.6	6.1
Average duration of fixation pauses	7.9	8.8	6.9
Average number of regressive movements per line	1.8	3.0	0.9

evidently needs training in reading more simple material until he is able to eliminate these confusion periods and make regular progress across the page.

Subject 47, a pupil from the third grade, maintains a consistently mature type of eye-movement habits throughout her reading. Her eye-movement record is shown in Plate XXX. As exhibited in Table XIX her averages and the medians for the third grade are, respectively, for average number of fixations per line, 6.1 and 8.9; for average duration of fixations, 6.9 and 7.9; and for average number of regressive movements, 0.9 and 1.8. In each characteristic her habits are at a higher level than the median for her grade. This degree of mastery of these fundamental elements makes it possible for her to take in the meaning of the printed page in large units, with her attention primarily upon content rather than upon the difficulties of the reading process. As shown by comparison of her averages with those in Table XVII, she is farther

advanced in span of recognition and regularity of eye-movements than in her average fixation time, which would suggest that the next element of these three to be emphasized in her reading process should be rate of recognition. It would not seem wise however to do this until the grade medians overtake her own averages, which may never occur. An examination of the eye-movement record of this subject, in Plate XXX, shows that in reading the first paragraph not a single regressive movement occurred. This rhythmic procedure is in striking contrast with the frequent oscillation in the eye-movements of Subject 52, as shown in certain lines in Plate XXIX.

Fourth-grade subjects —The records of three subjects from the fourth grade will be presented for the purpose of illustrating three combinations

TABLE XX

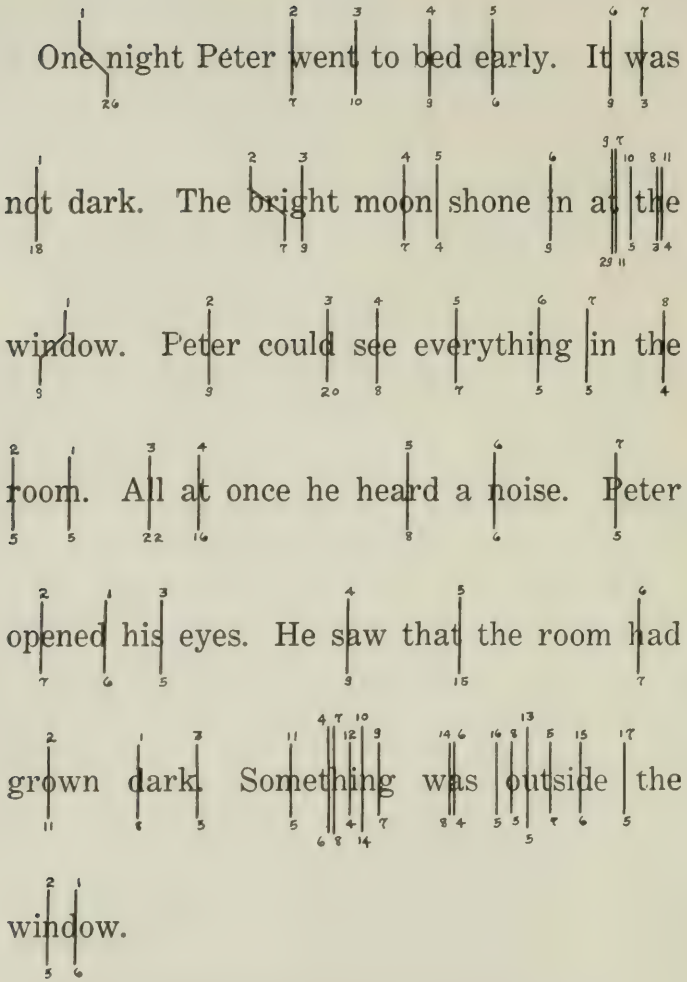
Comparison of Individual Records with Medians, Grade IV

	Median for Grade IV	Subject 62	Subject 60	Subject 59
Average number of fixations per line	7.3	7.4	12.5	10.8
Average duration of fixation pauses	6.7	9.3	6.0	8.4
Average number of regressive movements per line	1.4	1.0	3.3	2.5

of development at that growth stage. The medians for the fourth grade and the averages for each of these subjects are shown in Table XX.

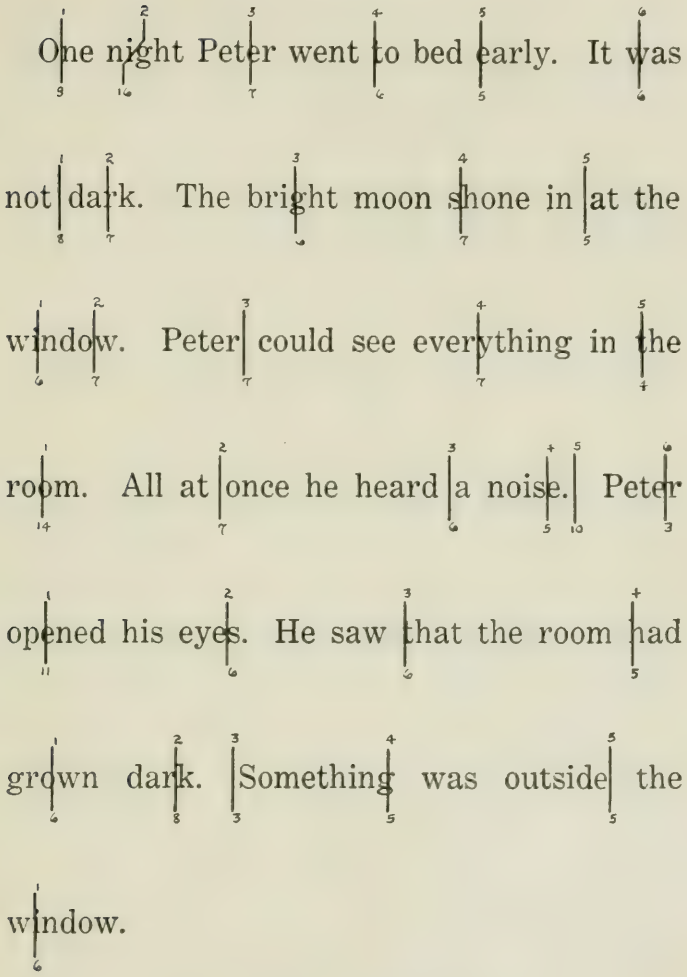
Subject 62, whose eye-movements record is shown in Plate XXXI, was ranked as a poor reader by the Monroe Silent Reading Test, but as average for her grade by the Gray oral test. A comparison of her eye-movement averages with the medians for her grade shows that she is up to normal in span of recognition, somewhat above average in regularity of eye-movements, but in average duration of fixations very much below normal. The grade median for average fixation time is 6.7, while this subject's average is 9.3. Previous investigations of eye-movements in reading have indicated that in general long fixation pauses occur when the subject is encountering thought difficulties. This fact should be kept in mind in interpreting the record of Subject 62. Her long average fixation time probably indicates that her difficulty is largely that of comprehension. The fact that she ranks higher in the Gray oral test than in comprehension in the Monroe Silent Reading Test

PLATE XXIX



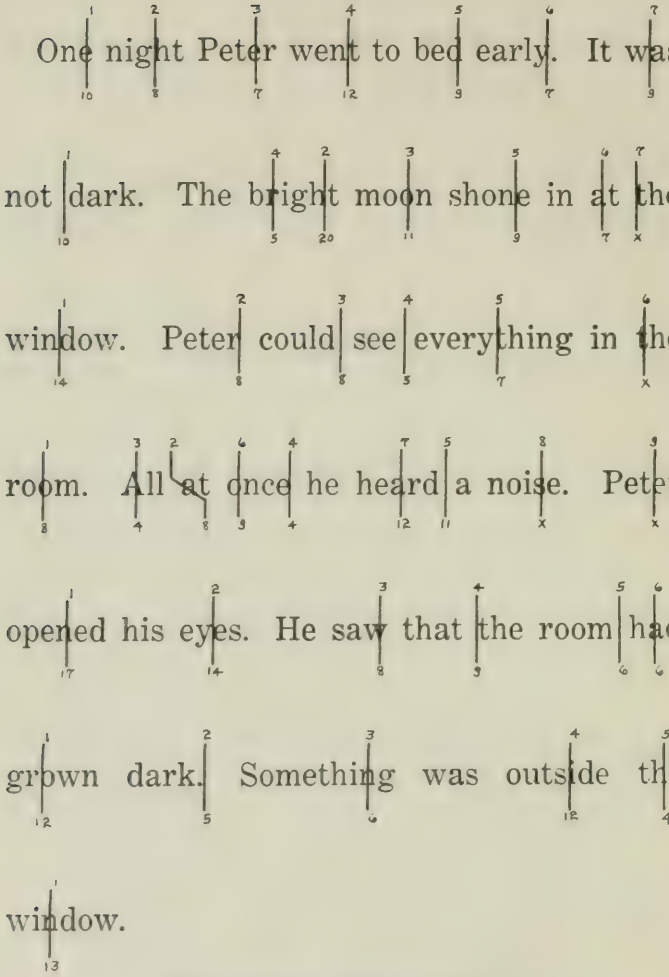
Silent reading by Subject 52, Grade III

PLATE XXX



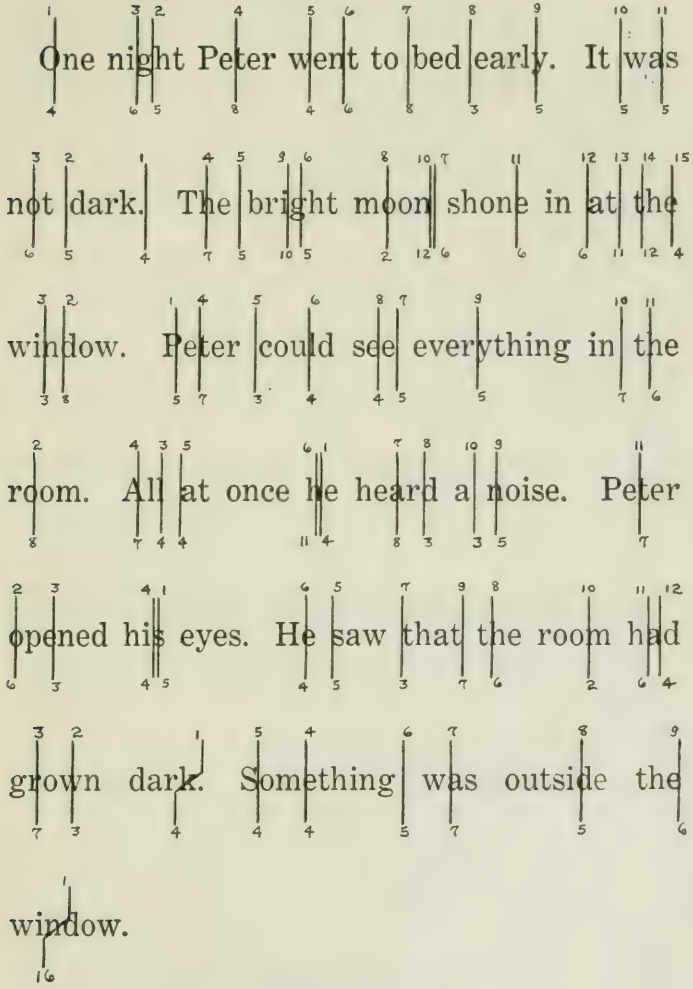
Silent reading by Subject 47, Grade III

PLATE XXXI



Silent reading by Subject 62, Grade IV

PLATE XXXII



Silent reading by Subject 60, Grade IV

would be in accord with such a diagnosis. Although this subject will eventually find it necessary to increase her speed of recognition, such an increase should come as the result of better habits of comprehension.

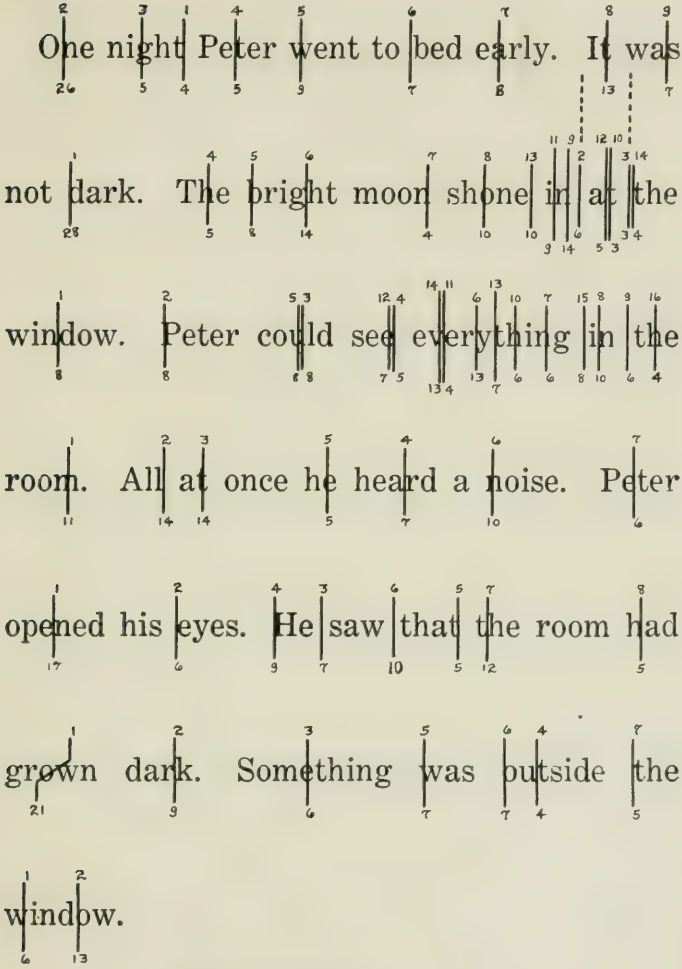
Subject 60, another fourth-grade pupil, exhibits the same type of results in respect to achievement scores on the Monroe and Gray tests as the pupil who has just been described. Plate XXXII gives the record of her eye-movements. This subject, however, has a very different combination of reading habits, as is shown by the data of Table XX. In respect to average duration of fixations her record is slightly above the grade median. But in respect to width of recognition-span and regularity of fixations she is notably deficient. In number of fixations per line, her average is 12.5 while the grade median is 7.3, and in number of regressive movements per line her average is 3.3 while the median for her grade is 1.4. The subject is below second-grade level in these two respects. She is very mature in respect to rate of recognition but in span of recognition and regularity of progress across the line her record indicates that special remedial work will soon be needed unless improvement occurs.

The third case from this grade, Subject 59, whose eye-movement record is shown in Plate XXXIII, is below standard in all three characteristics of eye-movements. This subject ranks low in both oral- and silent-reading tests and does poor work in her other school subjects. Her I.Q., as determined by the Illinois and Binet-Simon intelligence tests, was 96. The general character of her work would lead one to believe that she is one of those pupils who cannot be expected to reach the class medians. Certainly her deficiencies are general rather than specialized.

These three subjects from the fourth grade have exhibited three combinations of eye-movement habits. The first, Subject 62, was normal in span of recognition, above normal in regularity of eye-movements, but below the grade median in average fixation time. The second, Subject 60, was above normal in average fixation time, but below normal in span of recognition and regularity of eye-movements. The last pupil, Subject 59, was below the grade medians in all three characteristics. Since all three are in the same grade, they provide another illustration of the need of scientific diagnosis followed by specific teaching.

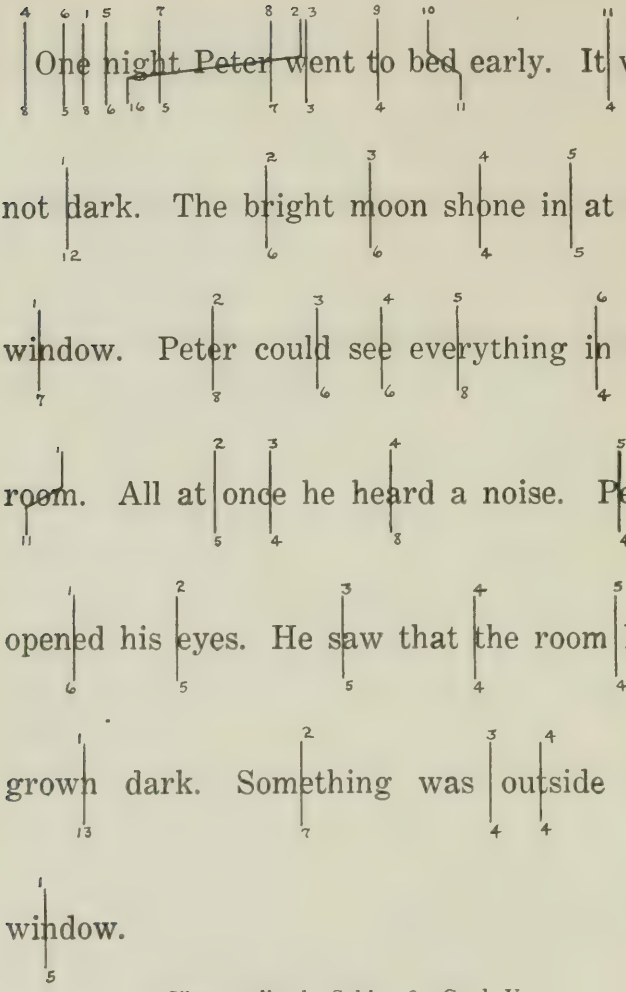
Fifth-grade subjects.—Four records have been selected from the fifth grade to illustrate the fact that while the growth curves show a high level of attainment on the part of the median pupils at this stage, there

PLATE XXXIII



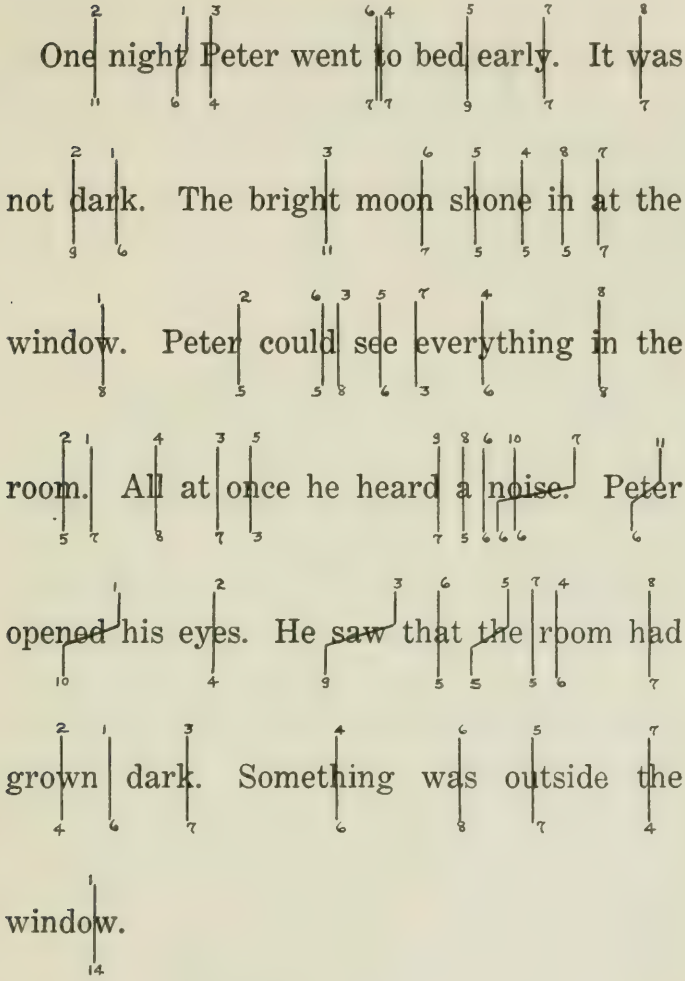
Silent reading by Subject 59, Grade IV

PLATE XXXIV



Silent reading by Subject 80, Grade V

PLATE XXXV



Silent reading by Subject 85, Grade V

are some of the less mature readers who have not yet mastered these fundamental elements of reading. The data for these four subjects, together with the medians for the fifth grade, are shown in Table XXI.

TABLE XXI

COMPARISON OF INDIVIDUAL RECORDS WITH MEDIANS, GRADE V

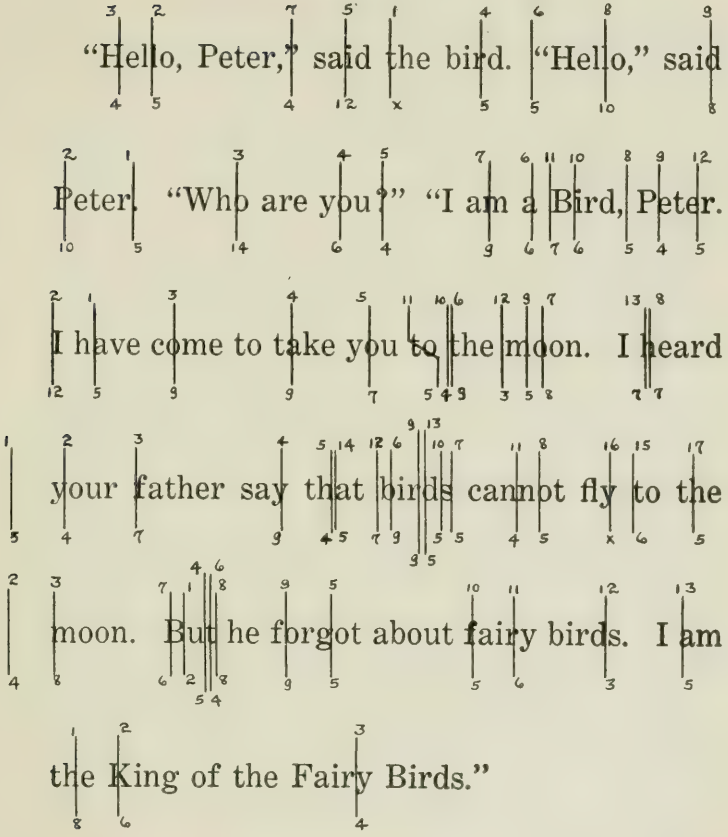
	Median for Grade V	Subject 80	Subject 85	Subject 78	Subject 70
Average number of fixations per line	6.9	6.1	8.4	11.7	9.6
Average duration of fixation pauses	6.3	6.2	6.5	6.4	5.4
Average number of regressive movements per line	1.3	0.2	3.4	3.2	2.5

Subject 80 is a mature fifth-grade reader, whose eye-movement record is shown in Plate XXXIV. He is superior to the median pupil in his grade in all three of the types of eye-movements which were measured. The regularity and rhythm of his movements are particularly noticeable. This subject's eye-movement habits are superior to those of the median high-school Senior.

The record of Subject 85 shows a marked contrast with that of the case just described. This subject, whose record is shown in Plate XXXV, ranked very low in both the Monroe and the Gray tests. His principal eye-movement deficiency consists of a large number of regressive movements and a rather narrow recognition-span. His average fixation time is not far from normal for his grade. The most serious difficulty of this pupil is caused by the lack of ability to move across the line in regular order, the regularity of his eye-movements being below second-grade standard. This one habit is sufficiently immature to cause poor reading regardless of any other deficiencies which the subject may possess.

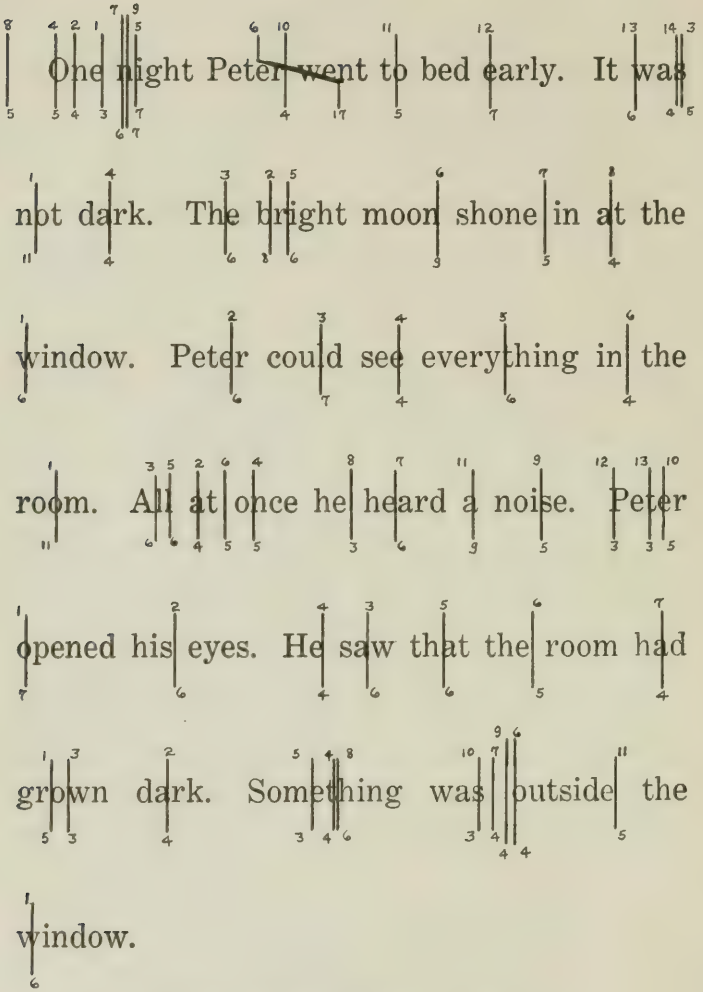
An example of a pupil who is normal in one of the characteristics of eye-movements but very much below average in the other two is shown by Subject 78. He is normal for his grade in respect to average fixation time, but in average number of regressive movements he ranks a little below the second-grade median. This pupil's eye-movement record, which is reproduced in Plate XXXVI, shows that he not only has a very narrow recognition-span but also makes a large number of regressive movements. In the fourth line of his record there is evidence

PLATE XXXVI



Silent reading by Subject 78, Grade V

PLATE XXXVII



Silent reading by Subject 70, Grade V

of some confusion when his eyes encountered the words "that birds." A similar situation appears in the following line upon the word "but." This pupil has by far the poorest record of any subject of the group selected from the fifth grade. He is badly in need of specific exercises for widening his recognition-span and developing a rhythmic type of eye-movements.

The last case selected from the fifth-grade group is Subject 70. She ranked lowest in her group in the silent reading comprehension test. Her fixations are very rapid, ranking even higher than the median for the college group, but her recognition-span is very narrow and her eye-movements are irregular. Her record, exhibited in Plate XXXVII, shows an erratic type of eye-control. In the silent reading of 19 lines of the story this subject made 21 fixations which were 3 twenty-fifths of a second or less in duration. It is doubtful whether any clear perception can be gained in such extremely short fixation pauses. It seems very probable that one cause of the many regressive movements is the fact that frequently her fixation pauses are so short that only a blurred perception results. If the serial order of her fixations is noted, it will be seen that it is extremely irregular, jerking back and forth with apparently no system at all. The reading of this subject can best be described as erratic in type. The width of her recognition-span needs to be increased, and her progress across the printed lines needs to become more regular. An emphasis upon clear fixations, even at the possible expense of speed at first, would doubtless help to eliminate some of her extremely short fixation habits.

Of the fifth-grade pupils just described the first furnishes an example of the high degree of eye-control possible by this stage of development; while the other three cases exhibit various combinations of deficiencies. The general shape of the growth curves for eye-movments suggests the desirability of rigidly checking up these fundamental reading habits at the beginning of this grade, in order that the pupil's attention may be free to attack his reading work wholly from the standpoint of content.

ANALYSIS OF HIGH-SCHOOL AND COLLEGE CASES

High-school Sophomores.—As an example of the reading of high-school pupils, the records of two subjects from the Sophomore class will be presented. A comparison of the averages of these pupils with the grade medians is given in Table XXII.

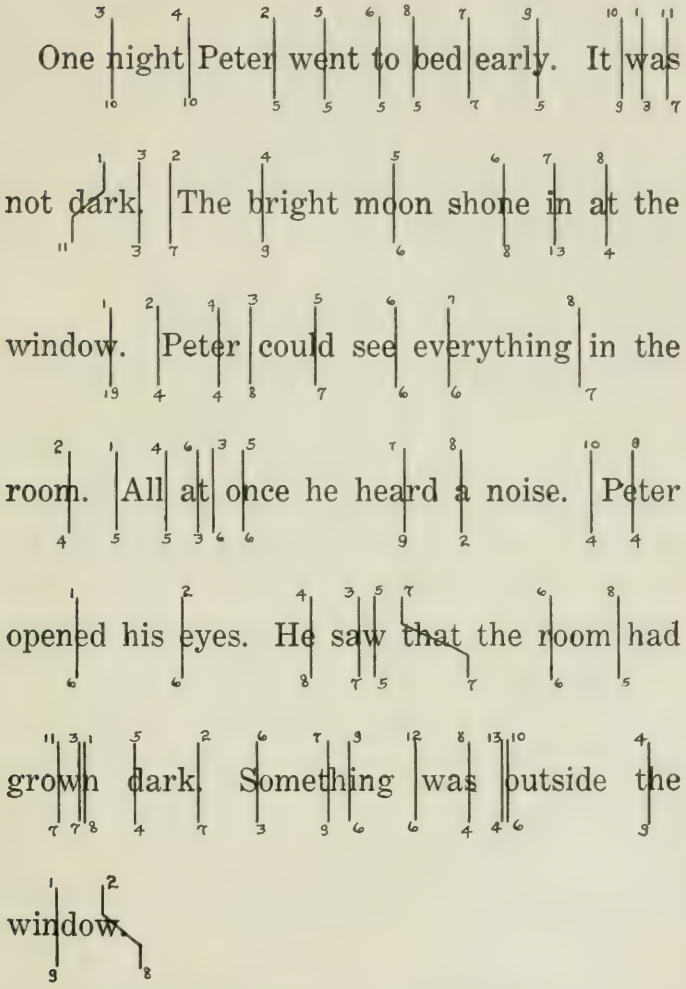
The eye-movement records of these two subjects are shown in Plates XXXVIII and XXXIX. Subject 124 has very mature reading habits,

PLATE XXXVIII

One night Peter went to bed early. It was not dark. The bright moon shone in at the window. Peter could see everything in the room. All at once he heard a noise. Peter opened his eyes. He saw that the room had grown dark. Something was outside the window.

Silent reading by Subject 124, high-school Sophomore

PLATE XXXIX



Silent reading by Subject 131, high-school Sophomore

particularly in respect to the width of recognition-span and regularity of eye-movements. Her average fixation time is slightly below the median for her grade. Subject 131 does not exhibit the same degree of maturity in these elements of reading. His recognition-span is very narrow and

TABLE XXII

COMPARISON OF INDIVIDUAL RECORDS WITH MEDIANS, HIGH-SCHOOL SOPHOMORES

	Median for Sophomores	Subject 124	Subject 131
Average number of fixation per line	5.8	4.0	9.4
Average duration of fixation pauses	6.2	6.9	6.4
Average number of regressive movements per line	0.7	0.2	2.4

he makes an excessively large number of regressive movements per line. These pupils have reached a stage in their school career where large demands are being made on their ability to read. Obviously, Subject 131 is at a marked disadvantage as compared with Subject 124. The bare process of reading must be a considerable burden to the former.

TABLE XXIII

COMPARISON OF INDIVIDUAL RECORDS WITH MEDIANS, COLLEGE SENIORS

	Median for College	Subject 175	Subject 172	Subject 174
Average number of fixations per line	5.9	4.2	6.6	3.6
Average duration of fixation pauses	6.3	6.5	6.0	8.0
Average number of regressive movements per line	0.5	0.2	1.6	0.0

Adult college students.—Three records will be presented showing the reading of adult students at the college level. Subject 175, who is a college Senior, made the eye-movement record which is shown in Plate XL. The comparison of her averages with the medians for the college group is given in Table XXIII. As shown by the smaller number of fixations per line and fewer regressive movements, she is superior in

these reading habits. Her average fixation time is slightly greater than that of the median for her group. The reading of a college student with less mature habits is illustrated in the record of Subject 172, whose eye-movement record is shown in Plate XLI. In average duration of fixations this subject is somewhat above normal, but his recognition-span is narrow and his eye-movements are not regular. He faces the heavy reading requirements of a college course with an immature development of certain fundamental elements of reading.

Subject 174, a college Senior whose eye-movement record appeared in Plate I, shows the most mature reading habits of any subject tested. Her eye-movements are perfectly regular throughout with no regressive movements, while her average number of fixations per line is only 3.6. However, her average fixation time, 8 twenty-fifths of a second, is 33 per cent greater than the median for college students. The general correlation between number and duration of fixations would indicate that it is entirely possible for this subject to reduce her fixation time to the median of her group, and thereby increase her speed of reading by one-third.

In the material just presented, the writer has attempted to point out how the grade medians for the three fundamental characteristics of eye-movement habits may be used in the analysis of individual cases.

TABLE XXIV

GRADE MEDIANS FOR EYE-MOVEMENTS IN ORAL READING

	IB	IA	II	III	IV	V	VI	VII	F	So	J	Se	Col
Average number of fixations per line	16.0	14.5	12.0	10.4	10.3	8.7	8.9	8.7	9.1	8.3	8.0	9.3	8.4
Average duration of fixations.....	19.2	12.8	9.8	10.1	7.7	7.2	7.3	7.0	6.7	6.6	7.0	6.5	7.5
Average number of regressive movements per line..	4.4	3.1	2.5	1.8	2.0	1.4	1.4	2.0	1.5	1.5	1.1	1.4	1.2

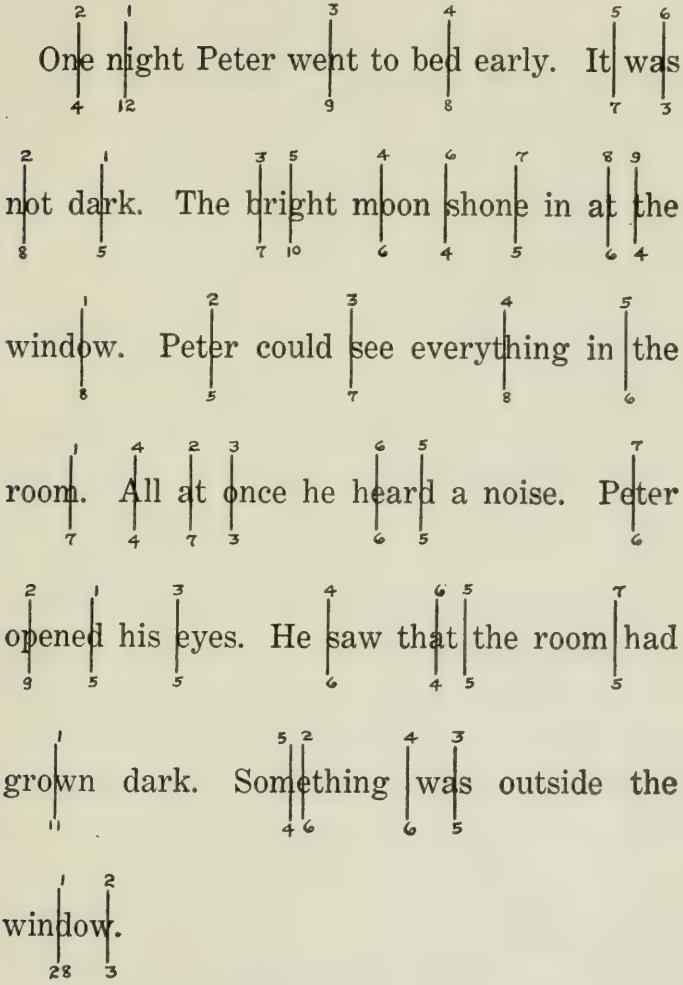
The illustrations have all been drawn from silent-reading records. Oral-reading medians may be used in the same manner, although in the interpretation the essential differences between the oral- and silent-reading processes must be kept clearly in mind. To provide a basis for comparison, Table XXIV is given, which exhibits the grade medians for the three types of eye-movement habits in oral reading.

PLATE XL

One night Peter went to bed early. It was not dark. The bright moon shone in at the window. Peter could see everything in the room. All at once he heard a noise. Peter opened his eyes. He saw that the room had grown dark. Something was outside the window.

Silent reading by Subject 175, college Senior

PLATE XLI



Silent reading by Subject 172, college Senior

The writer does not mean to intimate that a complete diagnosis of reading difficulties can be made upon the basis of eye-movement data alone. Every available type of analysis should be employed. He does propose, however, that a complete diagnosis cannot disregard the facts which eye-movement records reveal, and he further contends that span of recognition, average fixation time, and regular, rhythmic eye-movements are fundamental elements in the reading process.

When a careful analysis of the reading process for an individual pupil reveals one or more specific deficiencies, the logical conclusion is that if these deficiencies are very pronounced some specific form of treatment should follow. Small variations in the development of the different elements may be expected and in general may be disregarded. However, when a pupil follows a deviation from the curve of common growth to the extent that further progress in reading is delayed until a higher stage of maturity in the given element is reached, it is time to provide some special form of treatment for the improvement of the pupil's reading in this respect. In certain cases this specific treatment may need to be some purely formal or artificial exercise, unlike anything found in the ordinary reading assignments.

There has been some tendency in the literature of reading methods to question the practice of using any kind of an artificial device. There is a tendency to assert that no material should be used in school which does not have social value or which fails to meet the standards of social usage outside the school. Applied to reading this would mean that whatever training is needed should be acquired through the use of materials which have a meaningful content, or which at least have the same form as the selections which the pupil is regularly expected to read. No recognition is given to the distinction between exercises applied temporarily for a specific purpose, and material making up the regular content of a course in reading.

SPECIFIC TRAINING EXERCISES

The use of specific exercises for remedial work is recommended even though such materials be largely artificial in character. Inherently there seems to be no legitimate argument against the practice. This proposal may be illustrated by an analogy. Medical science has discovered that certain individuals suffer from a severe mental deterioration due to lack of secretion of the thyroid gland. Normally the human system generates the amount of thyroid secretion which is required from the nourishment obtained from ordinary foods. In the cases mentioned,

however, the deficiency is remedied not by taking greater quantities of ordinary food, but by the application in an entirely artificial manner of an extract of thyroid taken from the glands of sheep. A specific deficiency is treated by the application of a specific, but artificial, remedy. Thyroid extract is not included as one of the elements in an ordinary diet.

In exactly the same manner certain children are backward in reading because of lack of development in so ne specific ele nent, perhaps in span of recognition. The scientific method of attack is not to apply more and more of the general reading diet, but rather, after a careful diagnosis of the case, to prescribe a specific remedy for the defect. If the treatment provides a specific remedy it is a matter of secondary importance whether it be artificial or natural in character. No one questions the artificial administration of thyroid extract, even though it must be continued as a permanent treatment. There are even less grounds for objection to the temporary use of specific exercises in reading.

One type of remedy which has frequently been tried in reading is the use of short-exposure exercises. Where this method has been applied at the proper stage of development improvement has usually occurred. The principal difficulties which have been encountered seem to have been due either to lack of application of the exercises at the proper stage of development, or to lack of a systematic and standardized method of presenting the materials.

In connection with the present investigation a number of methods of presenting specific remedial exercises were experimentally tested. A description of one of these methods, together with certain suggestions for its use, may be of some value. A desirable method of administering remedial exercises should meet the following requirements: (1) the material should be of such a character that it can be presented to a small group as easily as to an individual; (2) it should be presented by some device which can be regulated automatically as to the time of exposure, making it possible to increase or decrease the exposure time to the limits of the median fixation time for the various school grades; (3) it should be possible easily to provide duplicates of carefully graded series of exercises for each of the specific elements needing development; (4) the device for presenting such material must be simple in operation and comparatively low in cost.

The apparatus which was found to meet these conditions most fully consists of a simple stereopticon device which uses a kinetoscope film. The exercises to be used are photographed upon a moving-picture film,

from which duplicates may be made in any desired quantity. For photographing such material a specially modified camera was constructed by means of which five lines of printed matter could be photographed per inch of film. Since the film can be obtained in any desired length it is possible to adjust the amount of film to the length of the exercise.

The exposure apparatus consists of a simple device by means of which the film is intermittently moved forward at any desired rate, the printed lines being projected upon a screen either by inserting the apparatus in front of the condensing lenses of any ordinary stereopticon lantern, or by using a simple lantern which can be attached. The film is moved by means of a clock mechanism operated by a weight. The rate of exposure is regulated by adjusting the length of the pendulum. A double escapement is provided, which makes possible a comparatively long period of exposure with a very short period of movement. As a final outcome, the units of material are presented on the screen in much the same manner as they would appear if presented through an ordinary moving-picture camera. The size of the unit and the rate of exposure can be absolutely controlled. This accurate time control makes the use of such a device greatly superior to the ordinary flash-card method, where the timing of the exposure is frequently inaccurate and irregular.

One further possibility in the use of the apparatus just described should be mentioned. Material can be presented through it as a continuous story, but exposed a unit at a time. These units may be either words or phrases of any desired length. For example, if a teacher wanted to present to beginners a series of short words in sentence form, the sentence would be printed and photographed as follows:

One
day
John
found
four
little
birds.

If the film upon which these words are printed were then moved upward through the stereopticon apparatus one unit at a time, the words would appear on the screen singly, but one following another in regular posi-

tion across the line. In reading the words, therefore, the pupil would not only be securing exercise in grasping a short word at a single eye-fixation, but he would also be getting the habit of moving his eyes regularly across the line as in ordinary reading. By substituting phrases of increasing length for the words, the exercises may be extended to meet the needs of the more mature reader who is deficient in some particular element of reading.

In using such materials as have just been described the purpose must be kept clearly in mind. The object is to provide a specific type of remedial exercise for a specific deficiency. This is entirely different from using such exercises for regular reading work, a practice which should certainly be condemned. The criticism of specific remedial teaching has generally come from those who confuse in their thinking the purposes of the two kinds of procedure. Such exercises would, to be sure, produce mechanical habits of reading if they were used continuously in the regular work of the school. The point to be noted is that they are not intended to be used for regular reading work, but only as specific training exercises to correct the lack of development in some particular element. This remedial work should probably be handled in a separate period as is ordinarily done in the teaching of phonics.

Three examples of the possible application of such remedial exercises will be given.

If the eye-movement record of a subject shows a considerably greater number of fixations per line than the median for the corresponding school grade it is evident that this subject has either a narrow span of recognition or a number of confusion periods in which sufficient eye-fixations are involved greatly to increase the average number of fixations per line. In the latter case the specific remedy would include drill in comprehension of simple materials, gradually increasing both degree of difficulty and rate of reading until habits of confusion are eliminated. In the former case, some specific exercise is needed for widening the average span of recognition. A suggested method of treatment would be to exercise this function with units of material of progressively increasing length, exposed by the apparatus which has been described, or by flash-cards, at a rate equal to the subject's normal fixation time. If flash-cards are used the speed of presentation should be regulated by a metronome or some simple pendulum device which can be adjusted to varying rates of movement. The size of the units of material should be gradually increased until the subject is able to recognize as wide a unit as that of the median for his grade.

If a subject shows a deficiency due to long fixation pauses a similar suggestion would be made. In this case material should be presented in units equal to the subject's average recognition-span, but exposed at a progressively increasing speed until the subject has reached a satisfactory stage of development.

In the third place, if the difficulty is due to an excessive irregularity of eye-movements, as indicated by a large number of fixations per line, the suggestion would be to present a paragraph or story by means of such an apparatus as has been described, building up the sentences unit by unit at a gradually increasing speed, but emphasizing throughout the development of a regular and rhythmic progression of eye-movements across the line.

In answer to the suggestions which have just been given the teacher will doubtless raise the question, How can we determine the number or duration of eye-fixations without the aid of an elaborate photographic apparatus? How may we know whether a pupil is normal or below normal in span of recognition, in speed of recognition, and in regularity of progress across the lines?

In reply to these questions the psychologist can say that it is not necessary for the teacher to make the elaborate and detailed form of analysis which is carried out in the laboratory. It is the function of the laboratory to supply the type of technical research which cannot be attempted in the classroom. Frequently the results of experimental work can be translated into conclusions which can be applied without the repetition of the experiments. For example, it has been shown that the emphasis on the memorizing of a reading selection by pupils in the I B grade causes some of the pupils to disregard the practice of following the lines of print with their eyes as they attempt to read. This indicates one result of a method which, in its early stages, develops reading attitude to a higher level of maturity than the various perceptual elements or the element of word-recognition. This fact having been discovered, it is not necessary for every first-grade teacher to photograph the eye-movements of her pupil in order to determine it again. She can accept the laboratory analysis and proceed in her teaching with a recognition of the fact that by the early emphasis upon a certain reading attitude she is simply carrying over to a later stage the problem of developing certain habits of eye-movements.

However, for the purpose of diagnosis of reading difficulties it is desirable that the teacher have at least a rough idea of whether a pupil makes few or many fixations per line, whether the fixations are long or

short in duration, and whether there are few or many regressive movements.

If a teacher will seriously undertake a few hours of practice in observing eye-movements simply by watching closely the eyes of another person while reading, a great deal of information can be gained. If the person who is reading holds the book slightly above the level of the eye, and the teacher takes a position just at one side of the book, she will find that, with the exercise of great care, it will be possible to get a fairly accurate count of the actual number of eye-movements. The movements which are most difficult to observe are those which are very small in extent. A device for making these movements more pronounced would be the enlargement of the type, which of course would increase the angle of the eye-movements. It has been shown in previous investigations that variation in size of type causes only a slight modification in the average number of fixations per line, provided the number of words per line remains the same. For present purposes this difference can be disregarded. In order to provide a sample of material for use in testing the number of eye-movements of a subject, three paragraphs of the selection which was used as a basis for the silent-reading medians are reproduced in large type in Plates XLII–XLIV. The pupil should hold these paragraphs 12 inches from his eyes while he reads silently. It is suggested that the teacher proceed as follows.

In the reading of the first paragraph quickly make a tally mark for each fixation of the eye in the reading of each line. It may be easier to count the movements than the fixations, in which case the teacher should add one fixation to the number of movements for each line, since in counting movements either the first or last fixation will not be counted. When the pupil has finished the paragraph the teacher should omit the first and last lines and then find the average number of fixations per line for the intervening part of the selection. If the pupil is allowed to read the paragraph only once the process may be repeated on the following day, as a check upon accuracy in counting, and if a variation is found an average of the two tests should be used. A comparison of this average with the medians in Table XVII will indicate the pupils who vary from the grade norms by a considerable amount. Since small errors in counting are likely to occur, slight variations from medians should be overlooked.

In the reading of the second paragraph find the total number of fixations for the entire paragraph and also the total time required for reading it. Multiply the number of seconds required for reading the

PLATE XLII

One night Peter went to bed early. It was not dark. The bright moon shone in at the window. Peter could see everything in the room. All at once he heard a noise. Peter opened his eyes. He saw that the room had grown dark. Something was outside the window.

Test paragraph for observation of number of fixations per line

PLATE XLIII

Tap, tap, came a noise at the window. "What is it?" called Peter. "It is I, Peter. Come to the window." Peter climbed out of bed and went to the window. There he saw a bird. This bird was so large that his eyes were as big as saucers.

Test paragraph for observation of duration of fixation pauses

PLATE XLIV

"Hello, Peter," said the bird. "Hello," said Peter. "Who are you?" "I am a Bird, Peter. I have come to take you to the moon. I heard your father say that birds cannot fly to the moon. But he forgot about fairy birds. I am the King of the Fairy Birds."

Test paragraph for observation of number of regressive movements per line

entire paragraph by 25 in order to reduce the time to units of twenty-fifths of a second. Then divide this total time by the total number of fixations, securing as a result the average duration of a fixation pause. Compare this with the medians in Table XVII, disregarding small variations.

In reading the third paragraph count only the backward or regressive movements of the eye. This will be more difficult, but with sufficient practice in both counting and keeping tally a fairly accurate result can be secured. Find the average number of regressive movements per line, after eliminating the first and last lines of the paragraph. Compare this average with the medians in Table XVII.

If a teacher is willing to practice several hours before attempting to use the results of her counting and will use great care in the observations, she will be able to secure results which will amply justify the time spent. Children's eye-movements are somewhat easier to count than those of adults, because their fixations are longer. With a due amount of practice the teacher will also find herself able to detect confusion periods in the reading of some of the children. The proposal of this chapter is in no sense that the regular teaching of reading should be made formal or artificial. It is exactly the opposite. Keep reading from becoming a formal process by treating specific deficiencies in a specific manner outside of the regular reading period. Do this by making an analytical diagnosis followed by specific remedial exercises. An intelligent use of such a plan should raise the general quality of reading through the direct development of fundamental habits.

SUMMARY

In chapter i of this monograph a contrast was drawn between mature and immature reading and the characteristics of ultimate maturity were described.

In chapter ii growth curves were shown for certain fundamental elements in reading. These curves were based upon the common achievement of a large group of cases, showing the nature of normal progress in reading under ordinary school conditions. While they indicated the most common route of travel toward the ultimate goal of maturity, they also gave evidence that some pupils were following different routes.

Chapter iii showed the effect of different methods of teaching at the first-grade level. The wide variations in the stage of development of different pupils in the various elements of reading indicated that from

the very beginning some of the pupils were starting toward maturity by a route which deviated from the one most commonly traveled.

In the present chapter the results of some of these deviations were shown. For those pupils who had proceeded too far in directions which did not point toward ultimate maturity, special analysis and remedial exercises were recommended. Suggestions were given as to possible methods of applying analysis to classroom situations.

Throughout the monograph the central trend of thought has been as follows. Determine by a careful analysis the characteristics of maturity. Find the fundamental elements in the reading process and study their curves of growth. In the light of these growth curves, analyze individual cases, and, where specific deficiencies are found, provide specific remedial teaching which will tend to raise these fundamental elements to the normal stage of development.

The writer has attempted to emphasize the fact that although methods of teaching may vary, all methods must ultimately lead toward maturity in reading; and that while the fundamental elements may be developed in different order and at different rates, ultimately any method must provide for the development of all elements which are really fundamental.

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